Cocker's

(Edward

ARITHMETICK.

BEING,

A Plain and familiar Method, ſuitable to the meaneſt Capacity, for the full Underſtanding of that incomparable Art, as it is now taught by the ableſt School-Maſters in CITY and COUNTRY.

By EDWARD COCKER, late Practitioner in the Arts of Writing, Arithmetick, and Engraving: Being that ſo long ſince promiſed to the World.

Peruſed and publiſhed

By JOHN HAWKINS, Writing-Maſter near St. *George*'s Church in *Southwark*, by the Author's correct Copy, and commended to the World by many eminent Mathematicans and Writing-Maſters in and near *London*.

The FIFTY-THIRD EDITION, carefully Corrected and Amended.

By GEORGE FISHER, *Accomptant*.
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TO his much honoured Friends *Manwaring Davies*, of the *Inner-Temple*, Eſq; and Mr. *Humphrey Davies* of St. *Mary Newington-Butts*, in the County of *Surry*.

John Hawkins, as an Acknowledgment of unmerited Favours, humbly dedicated this *Manual of Arithmetick*.

To the READER.

Courteous Reader,

I Having had the Happineſs of an intimate Acquaintance with Mr. *Cocker* in his Life-time, often ſollicited him to remember his Promiſe to the World, of publiſhing his *Arithmetick*, (but for Reaſons beſt known to himſelf) he refuſed it; and after his Death (the Copy falling accidentally into my Hands) I thought it not convenient to ſmother a Work of ſo conſiderable a Moment not Queſtioning but it might be as kindly accepted, as if it had been preſented by his own Hand. The Method is familiar and eaſy, diſcovering as well the Theorick as the Practick of that neceſſary Art of *Vulgar Arithmetick*. And in this new Addition there are many remarkable Alterations for the Benefit of the Teacher or Learner, which I hope will be very acceptable to the World; I have alſo performed my Promiſe in publiſhing the *Decimal Arithmetick*, which finds Encouragement to my Expectation, and the Bookſellers too. I am thine to ſerve thee,

John Hawkins.

BRITISH MUSEUM 30 OCT 58

Mr. *Edward Cocker*'s

POEME *or* PREFACE.

BY the ſecret Influence of Divine Providence, I have been inſtrumental to the Benefit of many, by Virtue of thoſe uſeful Arts, Writing *and* Engraving: *And do now with the ſame wonted Alacrity, caſt this my Arithmetical Mite into the publick Treaſury, beſeeching the Almighty to grant the like Bleſſing to theſe as to my former Labours.*

Seven Sciences ſupremely excellent,
Are the chief Stars in *Wiſdom*'s Firmament:
Whereof *Arithmetick* is one, whoſe Worth
The Beams of Profit and Delight ſhine forth;
This crowns the reſt, and makes Man's Mind complete,
This treat of Numbers, and of this we treate.

I have been often deſired by my intimate Friends to publiſh ſomething on this Subject, who, in a pleaſing Freedom have ſignified to me, that they expected it would be extraordinary. How far I have anſwered their Expectation, I know not; but this I know, that I have deſigned this Work not extraordinary abſtruſe or profound; but have by all Means poſſible within the Circumference of my Capacity, endeavoured to render it extraordinary uſeful to all thoſe, whoſe Occaſions ſhall induce them to make uſe of Numbers. *If it be objected, That the Books already publiſhed, treating of Numbers, are innumerable; I anſwer, that's but a ſmall Wonder, ſince the Art is infinite. But that there ſhould be ſo many excellent Tracts of* Practical Arithmetick *extant, and ſo little practiſed, is to me a great Wonder, knowing that as* Merchandize *is the Life of the Weal-publick, ſo* Practical Arithmetick *is the Soul of* Merchandize. *Therefore I do ingenuouſly profeſs, That in the Beginning of this Undertaking, the numerous Concerns of the honoured*

Merchant firſt poſſeſſeth my Conſideration: And how far I have accommodated this Compoſure for his moſt worthy Service, let his own profitable Experience be Judge.

Secondly, *for your Service moſt excellent Profeſſors, whoſe Underſtandings ſoar to the Sublimity of the Theory and Practice of this noble Science, was this Arithmetical Tractate compoſed; which you may pleaſe to employ as a Monitor to inſtruct your young* Tyroes, *and thereby take Occaſion to reſerve your precious Moments, which might be exhauſted that Way, for your more important Affairs.*

Thirdly, *For you the ingenious Off-ſpring of happy Parents who will willingly pay the full Price of Induſtry and Exerciſe for thoſe Arts and choice Accompliſhments, which may contribute to the Felicity of your future State: For you, I ſay, ingenious Practitioners, was this Work compoſed, which may prove the Pleaſure of your Youth, and the Glory of your Age.*

Laſtly, *For you the pretended Numeriſts of this Vapouring Age, who are more diſingeniouſly witty to propound unneceſſary Queſtions, than ingeniouſly judicious to reſolve ſuch as are neceſſary; for you was this Book compoſed and publiſhed, if you will deny yourſelves ſo much as not to invert the Streams of your Ingenuity, but by ſtudiouſly conferring with the Notes, Names, Orders, Progreſs, Species, Properties, Proprieties, Proportions, Powers, Affections, and Applications of Numbers delivered herein, become ſuch Artiſts indeed, as you now only ſeem to be. This* Arithmetick *ingeniouſly obſerved, and diligently practis'd, will turn to good Account to all that ſhould be concerned in Accompts; ſince all its Rules are grounded on Verity, and delivered with Sincerty; the Examples built up gradually from the ſmalleſt Conſideration to the greateſt; and all the Problems or Propoſitions, well weighed, pertinent and clear, and not one of them throughout the Tract, taken upon Truſt, therefore now,*

Zoilus and *Momus*, lie you down and die,
For theſe Inventions your whole Force defy,

Edward Cocker.

Courteous Reader,

BEING well acquainted with the deceaſed Author, and finding him knowing and ſtudious in the Myſteries of Numbers and Algebra, of which he had ſome choice Manuſcripts, and a great Collection of printed Authors in ſeveral Languages, I doubt not but he hath writ his Arithmetick ſuitable to his own Preface, and worthy Acceptation. Which I thought fit to certify, on a Requeſt to that Purpoſe made, to him that wiſheth thy Welfare, and the Progreſs of Arts.

John Collins.

Novemb. 27, 1677.

* * *

This Manual of Arithmetick *is recommended to the World by Us whoſe Names are ſubſcribed,* viz.

Mr. John Collins,
Mr. James Atkinſon, } *Mat.*
Mr. Peter Perkins,
Mr. Rich. Lawrence, *Sen.*
Mr. Eleazer Wigan,
Mr. Rich. Noble, *Guilford,*
Mr. William Norgate,
Mr. William Maſon,
Mr. Stephen Thomas,
Mr. Peter Storey,
Mr. Benj. Titchbourn,
Mr. Joſeph Symmonds,
Mr. Jer. Miles,
Mr. Joſiah Cuffly,
Mr. John Hawkins.

And generally approved by all Ingenious Artiſts.

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CHAP. I.

Notation of Numbers.

A*Rithmetick* is the Art of Numbering, or Knowledge which teacheth to number well. There are diverſe Species and Kinds of *Arithmetick* and *Geometry*, the which we do intend to treat of in Order, applying the Principles of the one to the Definition of the other. For as Greatneſs is the Subject of Geometry, ſo Number is the Subject of Arithmetick ; and if ſo, then their firſt Principles, and chief Fundamentals, muſt have like Definitions ; or, at leaſt, ſome Congruency.

2 Number is that, by which the Quantity of any Thing is expreſſed or numbered ; as the Unit is the Number by which the Quantity of the Thing is expreſſed or ſaid to be one, and two by which it is named two, and ½ half, by which it is named or called half, and the Root of 3, by which it is called the Root of 3 ; the like of any other

3. Hence it is that Unit is Number ; for the Part is of the ſame Matter that is its Whole, the Unit is Part of the Multitude of Units, therefore the Unit is of the ſame Matter that is the Multitude of Units ; but the Matter of the Multitude of Units is Number, therefore the Matter of Units is Number ; or elſe, if from a Number given no Number be ſubtracted, the Number given remaineth, as ſuppoſe 3 the given Number, if, as ſome ſuppoſe, 1 be no Number, then, if you ſubtract 1 from 3, there muſt remain 3 ſtill, which is very abſurd.

4. Hence it will be convenient to examine from whence Number hath its Riſe or Beginning Moſt Authors maintain, that Unit is the Beginning of Number, and itſelf no Number ; but, looking upon the Principles and Definitions in the firſt Rudiments of Geometry, we ſhall find that the

Definition of a Point is no Way congruous with the Definition of an Unit in Arithmetick ; and therefore One or Unit muſt be in the Bounds or Limits of Number, and conſequently the Beginning of Number is not to be found in the Number 1 ; wherefore making Number and Magnitude congruent in Principles, and like in Definitions, we make and conſtitute a Cypher to be the Beginning of Number, or rather the Medium between increaſing and decreaſing Numbers, commonly called abſolute or whole Numbers, and negative and fractional Numbers, between which nothing can be imagin'd more agreeable to the Definition of a Point in Geometry ; for as a Point is an Adjunct of a Line, and itſelf no Line, ſo is (o) Cypher an Adjunct of Number, and itſelf no Number: And as a Point in Geometry cannot be divided or increaſed into Parts ; ſo likewiſe (o) cannot be divided or increaſed into Parts ; for as many Points, tho' in Number infinite, do make no Line, ſo many (o) Cyphers, tho' in Number infinite, do make no Number. For the Line AB cannot be increaſed by the Addition of the Point C, neither the Number D be increaſed by the Addition of the (o) Cypher E ; for if you add nothing to 6, the Sum will be 6, (o) Cypher neither increaſing nor diminiſhing the Number ; but if it be granted that A B be extended or prolonged to the Point C, ſo that A C be made a continued Line, then A B is increaſed by the Addition of the Point C. In like Manner, if we grant D (6) be prolonged to E (o) ſo that DE (60) be a continued Number, making 60, then 6 is augmented by the Aid of (o) as conſtituting the Number (60) Sixty ; and furthermore that 1 or Unit is material, and a Number, and that (o) is the Beginning of Number, is proved by all Authors, although indirectly ; for the Tables of Sines and Tangents prove one Degree to be a Number, becauſe the Sine of 1 Degree is 174524, (the Radius being 10000000) and the Beginning of the Table is (o) and it anſwereth 00000, *&c.*

A ——— B
C
D 6
E 0
—
Sum 6

A — B — C

D El60
60l

5. Hence it is that Number is not Quantity diſcontinued, for that which is but one Quantity, is not Quality diſjunct: (60) Sixty, as it is a Number, is one Quantity, *viz.* one Number (60) Sixty; therefore, as it is a Number, it is not Quantity disjunct, for Number is ſome ſuch Thing in Magnitude, as Humidity in Water, for as Humidity extends itſelf through all and every Part of Water, ſo Number, related to Magnitude, doth extend itſelf through all and every Part of Magnitude. Alſo, as continued Water doth anſwer to a continued Humidity, ſo to a continued Magnitude doth anſwer a continued Number. As the continued Humidity of an intire Water ſuffereth the ſame Diviſion and Diſtinction that the Water doth; ſo the continued Number ſuffereth the ſame Diviſion and Diſtinction that the Magnitude doth. And thus much concerning the Definition and Principles of Number and Magnitude. We now come to treat of,

6. The Characters or Notes by which Numbers are ſignified, or by which a Number is ordinarily expreſſed; and they are theſe, *viz.* (0) Cypher or nothing, 1 One, 2 Two, 3 Three, 4 Four, 5 Five, 6 Six, 7 Seven, 8 Eight, 9 Nine. The Cypher, which though of itſelf it expreſſeth not any certain or known Quantity, yet is the Beginning or Root of Number, and the other 9 Figures are called ſignificant Figures or Digits.

7. In Number of any Sort, two Things are to be conſidered, *viz. Notation* and *Numeration.*

8. *Netation* teacheth how to deſcribe any Number by certain Notes and Characters, and to declare the Value thereof, being ſo deſcribed, that is, by Degrees and Periods.

9. A Degree conſiſts of three Figures, *viz.* of three Places, comprehending Units, Tens, and Hundreds; ſo 265 is a Degree, and the firſt Figure (5) on the right Hand, ſtands ſimply for his own Value, being Units, or ſo many Ones, *viz.* Five; the ſecond in Order from the Right ſignifies as many Times Ten as there are Units contained in it, *viz.* Sixty; the third in the ſame Order ſignifies ſo many Hundreds as it contains Units, ſo will the Expreſſion of the Number be Three hundred ſixty five, *&c.*

10. A Period is when a Number conſiſts of more than 3 Figures or Places, and whoſe proper Order is to prick

every third Place, beginning at the right Hand, and ſo on to the Left; ſo the Number 63452 being given, it will be diſtinguiſhed thus, 63,452, and expreſſed thus, Sixty three thouſand, four hundred fifty two; likewiſe 4,578,236,782, being diſtinguiſhed, as you ſee, will be expreſſed thus, Four thouſand, five hundred ſeventy eight Millions, two hundred thirty ſix thouſand, ſeven hundred eighty two.

11. Number is either abſolute or negative.

12. An abſolute, or intire, whole, increaſing Number, is that by which, annexing another Figure or Cypher, it becomes ten times as much as it ſtood for before; and if two Figures or Cyphers be annexed, it makes an hundred times as much as it ſtood for before, *&c.* As if you annex to the Figure 6 a Cypher, then it will be (60) Sixty; ſo if two Cyphers are annexed, then it will be (600) Six hundred, and if you annex to it (4) Four, then it will be (64) Sixty four; and if you annex (78) Seventy eight, it will be then (678) Six hundred ſeventy eight, *&c.*

13. A negative, or broken, fractional decreaſing Number, is that by which, prefixing a Point or Prick toward the left Hand, its Value has decreaſed from ſo many Units, to ſo many tenth Parts of any Thing; and if a Point and (0) Cypher or Digit be prefixed, it will be then ſo many hundred Parts; and if a Point and two Cyphers or Digits be prefixed, its Value is decreaſed to be ſo many thouſand Parts; as if you would prefix before the Figure 3 a Point (.) or Prick, thus (.3) it is then decreaſed from 3 Units, or 3 Integers, to three tenth Parts of an Unit, or an Integer: And if you prefix a Point and Cypher thus (.03) it is decreaſed from three Integers to 3 hundred Parts of an Integer; and by this Means 5 *l.* abſolute, by prefixing of a Point, will be decreaſed to 5 *l.* negative; which is 5 tenth Parts of a Pound, equal in Parts to 10 Shillings, and ſo, by prefixing of more Cyphers or Digits, its Value is decreaſed in a decuple Proportion *ad infinitum.* As in the following Scheme, or rather Order of Numbers, we have placed (0) Cypher in its due Place and Order, as it is in the Beginning and Medium of Number; for, going from (0) towards the left Hand, you deal with intire, abſolute, whole, increaſing Numbers.

In

Increaſing Numbers.									Decreaſing Numbers.			
29	376	543	250	2	1	0	1	2	345	678	979	3
mm	mmm	mmm	mmm	C	X	U	X	C	mmm	mmm	mmm	m
mm	mmm	mmm							XC	mmm	mmm	m
mm	CX	CX								X	mmm	m
X											XC	

But, going from (0) the Place of Units towards the right Hand, you meet with broken, negative, fractional, and decreaſing Numbers. And hence it follows, that Multiplication increaſeth the Product in abſolute Numbers, but decreaſeth the Product in negative Numbers. Alſo Diviſion decreaſeth the Quotient in whole Numbers, and increaſeth it in negative fractional Numbers.

An abſolute, intire, whole, increaſing Number hath always a Point prefix'd towards the right Hand; and therefore,

15. A negative, broken, decimal, decreaſing Number hath always a Point prefix'd towards the left Hand. When we expreſs Integers or whole Numbers, as 5 Pounds, 5 Feet, 26 Men, we uſually annex a Point or Prick after the Number thus,

l. feet. men. inch.
5. 5. 26. 347.

But when we expreſs Decimals, or Numbers that are denied to be intire, or decreaſing Numbers, we do commonly prefix a Point or Prick before the ſaid decimal or decreaſing Number thus, (.3) that is three Tenths, or 3 Primes (.03) that is 3 Hundredths, or 3 Seconds.

16. A whole or abſolute Number is an Unit, or a compoſed Multitude of Units, and it is either a Prime, or elſe a compound Number.

17. Prime Numbers amongſt themſelves are thoſe which have no Multitude of Units for a common Meaſure, as 8 and 7, or 10 and 13, becauſe not any Multitude of Units can equally meaſure or divide them without a Remainder.

18. Compound Numbers amongſt themſelves are thoſe which have a Multitude of Units for a common Meaſure, as 9 and 12, becauſe three meaſures them exactly, and abbreviates them to three and four.

19. A broken Number, commonly called a Fraction, is a Part or Parts of a whole Number, *viz.* a Part of an Integer, as $\frac{1}{3}$ one Third is one third Part of an Unit.

20. A broken Number or Fraction conſiſts of two Parts, *viz.* the Numerator and Denominator.

21. The Numerator and Denominator of a Fraction are ſet one over the other, with a Line between them; and the Numerator is ſet above the Line, and expreſſeth the Parts therein contained.

22. The Denominator of a Fraction is the inferior Number placed below the Line, and expreſſeth the Number of Parts, into which the Unit or Integer is divided; and let $\frac{3}{4}$ be the Fraction given, ſo ſhall 3 be the Numerator, and doth expreſs or number the Multitude of Parts contained in this Fraction, for $\frac{3}{4}$ is a Fraction compounded of Fourths or Quarters, and the Figure 3 in numbering ſhews us, that in that Fraction there are 3 of the 4th Parts of Quarters; alſo in the ſame Fraction 4 is the Denominator, and doth expreſs the Quality of the Fraction, *viz.* that the Whole or Integer is divided into four equal Parts.

23. A broken Number is either proper or improper; *viz.* proper when the Numerator is leſs than the Denominator, for $\frac{3}{4}$ is a perfect proper Fraction; but an improper Fraction hath its Numerator greater, or at leaſt equal to the Denominator; thus $\frac{13}{8}$ is an improper Fraction, the Reaſon is given in the Definition.

24. A proper broken Number is either Simple or Compound, *viz.* Simple when it hath one Denominator, and Compound when it conſiſteth of divers Denominators; if $\frac{3}{4}\frac{1}{3}\frac{0}{2}\frac{1}{1}\frac{2}{0}\frac{5}{0}$ were given, we ſay they are each of them Single or Simple Fractions, becauſe they conſiſt but of one Numerator, and one Denominator: But, if $\frac{2}{4}$ of $\frac{9}{12}$ of $\frac{35}{100}$ of a Pound Sterling were given, we ſay that it is a compound broken Number or Fraction, becauſe the Expreſſion and Repreſentation conſiſt of more Denominators than one; and ſuch, by ſome, are called Fractions of Fractions; they have always this Particle (of) between them.

25. When a ſingle broken Number or Fraction hath for its Denominator a Number conſiſting of an Unit in the firſt Place towards the left Hand, and nothing but Cyphers from the Unit towards the right Hand, it is then the more

aptly and rightly called a decimal Fraction; under this Head are all our decreaſing Numbers placed, and in our 13th Definition, called Negatives; and by the Order there preſcribed, we order them to be Decimals, by ſigning a Prick or Point before the Numerator, rejecting the Denominator: Therefore, according to our laſt Rule, $\frac{5}{10}$ $\frac{5}{100}$ $\frac{5}{1000}$, are Decimals. A decimal Fraction may be expreſſed without its Denominator (as before) by prefixing a Point or Prick before the Numerator of the ſaid Fraction, and then ſhall the former Fractions $\frac{5}{10}$ and $\frac{25}{1000}$ ſtand thus, 5, and 325.

But oftentimes, as in the ſecond and fourth Fractions $\frac{25}{1000}$, and $\frac{20}{1100}$, a Prick or Point will not do without the Help of a Cypher or Cyphers prefixed before the ſignificant Figures of the Numerator, and therefore, when the Numerator of a decimal Fraction conſiſteth not of ſo many Places as the Denominator hath Cyphers, fill up the void Places of the Numerator with prefixing Cyphers before the ſignificant Figures of the Numerator, and then ſign for a Decimal; ſo ſhall $\frac{5}{100}$ be .05, $\frac{25}{1000}$ will be .025, and $\frac{72}{10000}$ will be .0072. Now by this we may eaſily diſcover the Denominator having the Numerator; for always the Denominator of any decimal Fraction conſiſts of ſo many Cyphers, as the Numerator hath Places, with an Unit prefix'd before the Cypher, *viz.* under the Point or Prick.

26. A decimal Number or Fraction is expreſſed by Primes, Seconds, Thirds, Fourths, *&c.* and it is a Number decreaſing. Here, inſtead of natural and common Fractions, as $\frac{3}{4}$ of a Thing, we order the Thing or Integer into Primes, Seconds, Thirds, Fourths, Fifths, *&c.* that our Expreſſion may be conſonant to our former Order.

27. In Decimal Arithmetick, we always imagine that all intire Units, Integers, and Things, are divided firſt into ten equal Parts, and theſe Parts ſo divided we call Primes; and, Secondly, we divide alſo each of the former Primes, into other ten equal Parts, and every one of theſe Diviſions we call Seconds; and, Thirdly, we divide each of the ſaid Seconds into ten other equal Parts, and thoſe ſo divided we call Thirds; and ſo by decimating the former, and ſubdecimating theſe latter, we run on *ad infinitum.*

28. Let a Pound *Sterling*, *Troy-weight*, *Avoidupoiſe-weight*, *Liquid-meaſure*, *Dry-meaſure*, *Long-meaſure*, *Time*, *Dozen*, or any other Thing or Integer be given to be decimally divided; in this Notion premiſed, we ought to let the firſt Diviſion be Primes, the next Diviſion, Seconds, the next Thirds, *&c.* So one Pound Sterling being 20 Shillings, when divided into ten equal Parts, the Value of each Part will be 2 Shillings; therefore one Prime of a Pound Sterling will ſtand thus, (.1) which is in Value 2 Shillings; 3 Primes will ſtand thus, (.3) and that is in Value 6 Shillings. Again, a Prime or .1 being divided into ten equal Parts, each of thoſe Parts will be one Second, and is thus expreſſed, (.01) and its Value will be found 2*d.* Farthing, and $1\frac{6}{10}$ of a Farthing; and ſo will .05 ſignify one Shilling or five Seconds. And if .01 be divided into ten other equal Parts, each of thoſe Parts ſo divided will be Thirds, and will ſtand thus, .001, and its Value will be found to be .96 of a Farthing, or $\frac{96}{100}$ of a Farthing, and .009 Thirds will be 2*d.* and .64 of a Farthing, or $\frac{64}{100}$ of a Farthing. *&c.* So that .375 will be found to repreſent 7*s.* 6*d.* for the three Primes are 6 Shillings, and the 7 Seconds are 1*s.* 4*d.* and $\frac{2}{10}$ of a Penny, and the 5 Thirds are 1 Penny, $\frac{8}{10}$ of a Penny, both which added together make 7*s.* 6*d.*

29. If you put any Bulk or Body, repreſenting an Integer, if it be decimally divided, then the Parts in the firſt Decimation are Primes, the next Seconds, and the next Decimation is Thirds, the next Fourths, *&c.* As let there be given a Bullet of Lead, or ſuch like, whoſe Weight let it be 50*l.* *Troy*, this is called an Unit, Integer, or Thing; then will the like Weight and Matter make 10 others, the which together will be equal to 50*l.* and will weigh each of them 5*l.* apiece; take of the ſame Matter, and equal to 5*l.* make 10 more, then each of thoſe weigh 6 Ounces apiece; alſo, if again, you take 6 Ounces and thereof make 10 other ſmall Bullets, each of them will weigh 12 Penny-weights *Troy*; and thus have you made Primes, Seconds, and Thirds, in Reſpect of the Integer, containing 50*l.* *Troy Weight*; ſo that 5 Primes are equal to the half Maſs, and 2 Primes, and 5 Seconds, are a Quarter of the Maſs, and therefore one of the firſt Diviſion,

2 of the ſecond Diviſion, and 5 of the third Diviſion, will be equal in Weight to half a Quarter of the Maſs, and contains 6*l.* 2 Ounces.

30. When a decimal Fraction followeth a whole Number, you are to ſeparate or part the Decimal from the whole Number by a Point or Prick; ſo if 75 followed the whole Number 32, ſet them thus, 32.75. You ſhall find that diverſe Authors have divers Ways in expreſſing mixt Numbers, as thus, 32|75, or $32|\frac{75}{100}$ or $32|\dot{7}\dot{5}$, but you will find that 32.75, thus placed and expreſſed, are the fitteſt for Calculation.

31. A mixt Number hath two Parts, the whole and the broken; the whole is that which is compoſed of Integers, and the broken is a Fraction annexed thereunto. So the mixt Number, $36\frac{8}{12}$ being given, we ſay, that 36 is the whole Number, which is compoſed of Integers; and the $\frac{8}{12}$ is the broken Number annexed, which ſheweth that one of the former Integers (of that 36) being divided into 12 Parts, $\frac{8}{12}$ doth expreſs 8 of thoſe 12 Parts more, belonging to the ſaid 36 Integers.

32. Denominative Numbers are of one, or of many; and thoſe are of diverſe Sorts and Kinds, *viz.* Singular called Unit, as one; and Plural a Multitude, as 2, 3, 4, 5; Single, of one Kind only called Digits, as 1, 2, 3, 4 5, 6, 7, 8, 9; and Compound of many, 10, 11, 12, *&c.* 102, 367, *&c.*

Proportionable, as Single, Multiple, Double, Triple, Quadruple, *&c.* Denominate, as Pounds, Shillings, Pence; Undenominate, as 1, 2, 3, *&c.* Perfect, as 6, 28, 496, 8128, 130816, 2096128, *&c.* whoſe Parts are equal to the Numbers; imperfect, unequal, and more than the Sum, as 12, to 1, 2, 3, 4, 6. Numbers commenſurable, as 9, 12, becauſe 3 meaſures them both; but 10 and 17 are incommenſurable, becauſe no one common Number or Meaſure can meaſure them; Lineal in Form of a Line, as . . . . Superficial, in Form of a Superficies or Plane, as :: : :: : or : :, *&c.* and Number cubical or ſolid, in Form of a
: :
Cube. Thoſe two latter are otherwiſe called Figurative Numbers: There are alſo other Numbers called Tabular,

28. Let a Pound *Sterling*, *Troy-weight*, *Avoidupoiſe-weight*, *Liquid-meaſure*, *Dry-meaſure*, *Long-meaſure*, *Time*, *Dozen*, or any other Thing or Integer be given to be decimally divided; in this Notion premiſed, we ought to let the firſt Diviſion be Primes, the next Diviſion, Seconds, the next Thirds, *&c.* So one Pound Sterling being 20 Shillings, when divided into ten equal Parts, the Value of each Part will be 2 Shillings; therefore one Prime of a Pound Sterling will ſtand thus, (.1) which is in Value 2 Shillings; 3 Primes will ſtand thus, (.3) and that is in Value 6 Shillings. Again, a Prime or .1 being divided into ten equal Parts, each of thoſe Parts will be one Second, and is thus expreſſed, (.01) and its Value will be found 2*d.* Farthing, and $\frac{6}{10}$ of a Farthing; and ſo will .05 ſignify one Shilling or five Seconds. And if .01 be divided into ten other equal Parts, each of thoſe Parts ſo divided will be Thirds, and will ſtand thus, .001, and its Value will be found to be .96 of a Farthing, or $\frac{96}{100}$ of a Farthing, and .009 Thirds will be 2*d.* and .64 of a Farthing, or $\frac{64}{100}$ of a Farthing, *&c.* So that .375 will be found to repreſent 7*s.* 6*d.* for the three Primes are 6 Shillings, and the 7 Seconds are 1*s.* 4*d.* and $\frac{2}{10}$ of a Penny, and the 5 Thirds are 1 Penny, $\frac{8}{10}$ of a Penny, both which added together make 7*s.* 6*d.*

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Proportionable, as Single, Multiple, Double, Triple, Quadruple, &c. Denominate, as Pounds, Shillings, Pence; Undenominate, as 1, 2, 3, &c. Perfect, as 6, 28, 496, 8128, 130816, 2096128, &c. whoſe Parts are equal to the Numbers; imperfect, unequal, and more than the Sum, as 12, to 1, 2, 3, 4, 6. Numbers commenſurable, as 9, 12, becauſe 3 meaſures them both; but 16 and 17 are incommenſurable, becauſe no one common Number or Meaſure can meaſure them; Lineal in Form of a Line, as .... Superficial, in Form of a Superficies or Plane, as :: : ::: or : :, &c. and Number cubical or ſolid, in Form of a
: :
Cube. Thoſe two latter are otherwiſe called Figurative Numbers: There are alſo other Numbers called Tabular,

lar, as Sines, Tangents, Secants, *&c.* Others that be called Logarithmetick, or borrow'd Numbers, fitted to Proportion for Eaſe, and ſpeedy Calculation of all manner of Queſtions.

CHAP. II.

Of the Natural Diviſion of Integers, and the ſeveral Denominations of the Parts.

1. AND, that we may advance methodically herein, we will begin with the main Pillars on which Arithmetick is founded, *viz.* the ſeveral Species of that Art: But firſt,

Of Money, Weights, &c.

2. The leaſt Denomination or Fraction of Money uſed in *England* is a Farthing, from which is produced the following Table, called the Table of Coin, *&c.*

1 Farth.	make	1 Farthing
4 Farth.	make	1 Penny
12 Pence	make	1 Shilling
20 Shil.	make	1 Pound

And therefore,

l. *s.* *d.* *qrs.*
1—20—12——4
——————————
1—20—240--960
1——12—48
1——4

The firſt of theſe Tables, *viz.* that on the Left Hand, is plain and eaſy to be underſtood, and therefore wants no Direction. In the ſecond Table above the Line, you have 1 *l.* 20 *s.* 12 *d.* 4 *qrs.* whereby is meant, that a Pound is equal to 20 Shillings, and 1 Shilling is equal to 12 Pence, and 1 Penny equal to 4 Farthings; under the Line is 1 *l.* 20 *s.* 240 *d.* 960 *qrs.* which ſignifies 1 *l.* to contain 20 Shillings, or 240 Pence, or 960 Farthings; in the ſecond Line below that is 1 *s.* 12 *d.* 48 *qrs.* the firſt ſtanding under the Denomination of Shillings, whereby it is to be noted, that 1 Shilling is equal to 12 Pence, or 48 Farthings; and likewiſe that below that, one Penny is equal in Value to four Farthings; underſtand the like Reaſon in the following Tables of Weight, Meaſure, Time, Motion, and Dozens.

Of Troy Weight.

3. The leaſt Fraction or Denomination of Weight, uſed in *England*, is a Grain of Wheat gathered out of the Middle of the Ear, and well dried; from whence are produced theſe following Tables of Weight, called *Troy Weight*.

32 Grains of Wheat	make	24 Artificial Grains.
24 Artificial Grains		1 Penny-weight.
20 Penny-weights		1 Ounce.
12 Ounces		1 Pound Troy-weight.

And therefore,

l.	*oun.*	*p. w.*	*grains.*
1	12	20	24
1	12	240	5760
	1	20	480
		1	24

Troy Weight ſerveth to weigh Bread, Gold, Silver, and Electuaries; it alſo regulateth and preſcribeth a Form how to keep the Money of *England* at a certain Standard.

Of Apothecary's Weight.

4. The *Apothecaries* have their Weights deduced from *Troy-weight*, a Pound *Troy* being the greateſt Integer, a Table of whoſe Diviſion and Subdiviſion followeth, *viz.*

1 Pound	make	12 Ounces
1 Ounce		8 Drams
1 Dram		3 Scruples
1 Scruple		20 Grains

And therefore,

l.	*oun.*	*drams.*	*ſcrup.*	*gr.*
1	12	8	3	20
1	12	96	288	5760
	1	8	24	480
		1	3	60
			1	20

5. Thus much concerning *Troy Weight*, and its derivative Weights; beſides which, there is another Kind of Weight uſed in *England*, known by the Name of *Averdupoiſe Weight*, (1 Pound of which is equal to 14 Ounces 12 Penny-weights *Troy Weight*) and it ſerveth to weigh all Kinds of Grocery-wares; and alſo Butter, Cheeſe, Fleſh, Wax, Tallow, Roſin, Pitch, Lead, &c. the Table of which is as followeth:

A Table of Avoidupoiſe-weight.

4 Quarters of a Dram	make	1 Dram
16 Drams		1 Ounce
16 Ounces		1 Pound
28 Pounds		1 Quarter of a Hundred
4 Quarters		1 Hun. Wt. or 112 *lb.*
20 Hundred		1 Tun

And therefore,

Tun	*C.*	*qr.*	*l.*	*oun.*	*dram.*	*qrs.*
1	20	4	20	16	16	4
1	20	80	2340	35040	573440	2293760
	1	4	112	1792	29672	114688
		1	28	448	7168	28672
			1	16	256	1024
				1	16	64
					1	4

Wool is weighed with this Weight, but only the Diviſions are not the ſame.

7 Pounds	make	1 Clove
2 Cloves		1 Stone
2 Stones		1 Todd
6 Todd 1 Stone		1 Wey
2 Weys		1 Sack
12 Sacks		1 Laſt.

And therefore,

laſt	*ſack*	*wey*	*todd*	*ſtone*	*cloves.*	*lb.*
1	12	2	6½	2	2	7
1	12	24	150	312	624	4368
	1	2	13	26	52	364
		1	6½	13	26	182
			1	2	4	28
				1	2	14
					1	7

Note, That in ſome Countries the Wey is 256 *lb.* *Avoirdupoiſe,* as in the *Suffolk* Wey; but in *Eſſex* there are 236 *lb.* in a Wey.

6. The leaſt denominative Part of Liquid Meaſure is a Pint, which was formerly taken from *Troy-Weight* (1 Pound of Wheat, *Troy-Weight*, making a Point of Liquid Meaſure) but ſince, by a late Act of Parliament, to prevent Fraud in the Exciſe, the Pint Beer Meaſure is to contain 35¼ ſolid Inches, and the Pint Wine 28⅞ the like Inches, *&c.*

A Table of Liquid Meaſure.

35¼ Cubical Inches	make	1 Pint Beer Meaſure
28⅞ Cubical Inches		1 Pint Wine Meaſure
2 Pints		1 Quart
2 Quarts		1 Pottle
2 Pottles		1 Gallon
8 Gallons		1 Firkin of Ale, or Soap
9 Gallons		1 Firkin of Beer
10 Gallons and half		1 Firkin of Salmon or Eels
2 Firkins		1 Kilderkin
2 Kilderkins		1 Barrel
42 Gallons		1 Terce of Wine
63 Gallons		1 Hogſhead
2 Hogſheads		1 Pipe or Butt
2 Pipes or Butts		1 Tun of Wine

And therefore,

Tuns	*pipes*	*hhds.*	*gall.*	*pints*
1	2	2	63	8
1	2	4	252	2016
	1	2	126	1098
		1	63	594
			1	8

7. The leaſt denominative Part of Dry-Meaſure is alſo a Pint, and this is likewiſe taken from *Troy-Weight*.

A Table of Dry Meaſure.

1 Pound *Troy*	make	1 Pint
2 Pints		1 Quart
2 Quarts		1 Pottle
2 Pottles		1 Gallon

2 Gallons	make	1 Peck.
4 Pecks		1 Buſhel.
2 Buſhels		1 Coomb.
2 Coombs		1 Quarter.
4 Quarters		1 Chaldron.
5 Quarters		1 Wey.
3 Weys		1 Laſt.

And therefore,

laſt.	*wey.*	*qrs.*	*coom.*	*buſh.*	*pecks.*	*gall.*	*pint.*
1	2	5	2	4	4	2	8
1	2	10	20	80	320	940	5120
	1	5	10	40	160	320	2560
		1	2	8	32	65	512
			1	4	16	32	256
				1	4	8	64
					1	2	16
						1	8

8. The leaſt denominative Part of Long-meaſure is a Barley-corn well dried, and taken out of the Middle of the Ear, whoſe Table of Parts followeth:

2 Barley-corns	make	1 Inch.
12 Inches		1 Foot.
3 Feet		1 Yard.
3 Feet 9 Inches, or a Yard and a Quarter		1 Ell *Engliſh.*
6 Feet		1 Fathom.
5 Yards and a Half		1 Pole, Perch, or Rod.
40 Poles or Perches		1 Furlong.
8 Furlongs		1 *Engliſh* Mile.

And therefore,

mile.	*furl.*	*poles.*	*yards.*	*feet.*	*inches.*	*bar.corn.*
1	8	40	5½	3	12	3
1	8	320	1760	5280	63360	190080
	1	4	220	660	7900	23760
		1	5½	66½	198	590
			1	3	36	108
				1	12	36
					1	3

And note, that the Yard, as alſo the Ell, is uſually divided into Quarters, and each Quarter into 4 Nails.

Note alſo, That a Geometrical Pace is 5 Feet, and there are 1056 ſuch Paces in an *Engliſh* Mile.

9. The Parts of the ſuperficial Meaſure of Land are ſuch as are mentioned in the following Table, *viz.*

A Table of Land Meaſure.

40 Square Poles or Perches	make	1 Rood, or Quarter of an Acre.
4 Roods	make	1 Acre.

By the foregoing *Table of Land Meaſure*, you are informed what a Pole or Perch is; and by this, that 40 ſquare Perches is a Rood. Now a ſquare Perch is a Superficies very aptly reſembled by a ſquare Trencher, every Side thereof being a Perch of 5 Yards and a Half in Length, 40 of them is a Rood, and 4 Roods an Acre. So that a Superficies, that is 40 Perches long, and 4 broad, is an Acre of Land, the Acre containing in all 160 ſquare Perches.

10. The leaſt denominative Part of Time is one Minute, the greateſt Integer being a Year, from whence is produced this

Table of Time.

1 Minute	make	1 Minute.
60 Minutes	make	1 Hour.
24 Hours	make	1 Day natural.
7 Days	make	1 Week.
4 Weeks	make	1 Month.
13 Months, 1 Day, 6 Hours	make	1 Year.

But the Year is uſually divided into twelve unequal Calendar Months, whoſe Names, and the Number of Days they contain, are as follows. *viz.*

	Days.		Days.
Jan.	31	*July*	31
Febr.	28	*Aug.*	31
Mar.	31	*Sept.*	30
April	30	*Oct.*	31
May	31	*Nov.*	30
June	30	*Dec.*	31

So that the Year containeth 365 Days, and 6 Hours; but the 6 Hours are not reckoned, but only every fourth Year, and then there is a Day added to the latter End of *Febr.* and then it contains 29 Days; and that Year is called Leap-Year, and containeth 366 Days.

And here note, That, as the Hour isdivided into 60 Minutes, ſo each Minute is ſub divided into 60 Seconds, and each Second into 60 Thirds, and each Third into 60 Fourths, *&c.*

The Tropical Year, by the exacteſt Obſervation of the moſt accurate Aſtronomers, is found to be 365 Days, 5 Hours, 49 Minutes, 4 Seconds, and 21 Thirds.

CHAP. III.

Of the Species or Kinds of Arithmetick.

THere are ſeveral Species of this Art; and which may be termed either Natural, Artificial, Analytical, Algebraical, Lineal, or Inſtrumental: But what we are now to treat upon, relates to the ſingle Parts of Natural Arithmetick, ſo far as concerns Numeration; of which there are alſo four Kinds, viz. *Addition*, *Subtraction*, *Multiplication*, and *Diviſion*.

CHAP. IV.

Addition of whole Numbers.

ADdition is the Reduction of two or more Numbers of like Kind, together into one Sum or Total; Or, it is that by which diverſe Numbers are added together, to the End that the Sum or Total Value of them all may be diſcovered.

The firſt Number in every *Addition* is called the *Addible Number* or *Numbers* added; and the *Number*, invented by the *Addition*, is called the *Aggregate*, or Sum, containing the Value of he *Addition*.

The Collation of the Numbers is the right placing the Numbers given reſpectively to each Denomination, and the Operation is the Artificial Adding of the Numbers given together, in order to the finding out of the Aggregate or Sum.

2. In *Addition* place the Numbers given reſpectively the one above the other, in ſuch ſort, that the like Degree, Place, or Denomination, may ſtand in the ſame Series, *viz.* Units under Units, Tens under Tens, Hundreds under Hundreds, *&c.* Pounds under Pounds, Shillings

under Shillings, Pence under Pence, *&c.* Yards under Yards, Feet under Feet, *&c.*

3. Having thus placed the Numbers given (as before) and drawn a Line under them, add them together, beginning with the leſſer Denomination, *viz.* at the right Hand; and ſo on, ſubſcribing the Sum under the Line reſpectively; As for Example,

Let there be given 3352, 213, and 133, to be added together: I ſet the Units in each particular Number under each other, and ſo likewiſe the Tens under the Tens, *&c.* and draw a Line under them, as in the Margin; then I begin at the Place of Units, and add them together upwards, ſaying 3 and 3 are 6, and 2 make 8, which I ſet under the Line, and under the ſame Figures added together; then I proceed to the next Place, being the Place of Tens, and add them in the ſame Manner as I did in the Place of Units, ſaying 3 and 1 are 4, and 5 are 9, which I likewiſe ſet under the Line reſpectively; then I go to the Place of Hundreds, and add them up as I did the other, ſaying, 1 and 2 are 3, and 3 are 6, which is alſo ſet under the Line; and laſtly, I go to the Place of Thouſands, and, becauſe there is no other Figure to add to the 3, I ſet it under the Line in its reſpective Place, and ſo the Work is finiſhed; and I find the Sum of the 3 given Numbers to be 3698.

3352
213
133
———
3698

4. But if the Sum of the Figures of any Series exceedeth Ten, or any Number of Tens, ſubſcribe under the ſame the Exceſs above the Tens, and for every Ten carry one, to be added to the next Series towards the left Hand, and to go on till you have finiſhed your Addition; always remembring, that, how great ſoever the Sum of the Figures of the laſt Series is, it muſt all be ſet down under the Line reſpectively. So 3678 being given to be added to 2357, I ſet them down as is before directed, and as you ſee in the Margin, with a Line drawn under them, then I begin and add them together, ſaying 7 and 8 are 15, which is 5 above 10, wherefore I ſet 5 under the Line, and carry 1 for the Ten to be added to the next Series, ſaying, 1 that I carried and 5 is 6, and 7 are 13, wherefore I ſet down 3,

3678
2357
———
6035

and carry 1 (for the Ten) to the next Series; then I ſay, 1 that I carried, and 3 are 4, and 6 are 10; now, becauſe it comes to juſt 10, and no more, I ſet 0 under the Line, and carry 1 from the 10 to the next, and ſay, 1 that I carried, and 2 are 3, and 3 are 6, which I ſet down in its reſpective Place; thus the Addition is found to be 6035. Several Examples of this Kind follow.

Numbers to be added:
354867
573846
785946
347205
Sum 2061864

Numbers to be added:
748647
465834
76483
648400
Sum 1939364

Numbers to be added:
45346
38074
8437
933
76
Sum 92866

5. If the Numbers given to be added are contained under divers Denominations, as of *Pounds*, *Shillings*, *Pence*, and *Farthings*; or of *Tuns*, *Hundreds*, *Quarters*, *Pounds*, &c. Then, in this Caſe, having diſpoſed of the Numbers of each Denomination under others of the like Kind; beginning at the leaſt Denomination, (minding how many of one Denomination do make an Integer in the next) and having added them up, for every Integer of the next greater Denomination that you find therein contained, bear an Unit in Mind, to be added to the ſaid next greater Denomination, expreſſing the Exceſs reſpectively under the Line; proceed in this Manner until your Addition be finiſhed; the following Example will make the Rule plain to the Learner. Thus theſe following Sums being given to be added, *viz.* 136 *l.* 13 *s.* 4 *d.* 2 *qrs.* and 79 *l.* 07 *s.* 10 *d.* 3 *qrs.* and 33 *l.* 18 *s.* 9 *d.* 1 *qr.* alſo 15 *l.* 09 *s.* 05 *d.* 0 *qrs.* The Number being diſpoſed according to Order, will ſtand as in the Margin of the next Page. Then I begin at the Denomination of Farthings, and add them

up, ſaying, 1 and 3 are 4, and 2 make 6. Now I conſider, that 6 Farthings are 1 Penny 2 Farthings; whereof I ſet down the 2 Farthings in its Place under the Line, and keep it in Mind, to be added to the next Denomination of Pence; then I go on, ſaying, 1 that I carried, and 5 are 6, and 9 are 15, and 10 are 25, and 4 are 29; now I conſider, that 29 Pence are 2 Shillings and 5 Pence, therefore I ſet down 5 Pence in Order under the Line, and keep 2 in Mind, for the 2 Shillings to be added to the Shillings. Then I go on, ſaying, 2 that I carried, and 9 are 11, and 18 are 29, and 7 are 36, and 13 are 49; then I conſider, that 49 Shillings are 2 Pounds and 9 Shillings, wherefore I ſet the 9 Shillings under the Line, and carry the 2 for the 2 Pounds to the next and laſt Denomination of Pounds; and proceed, ſaying, 2 that I carried, and 5 make 7, and 3 are 10, and 9 are 19, and 6 are 25; then I ſet down 5, and carry 2 for the 2 Tens; and proceed, ſaying, 2 that I carry, and 1 are 3, and 3 are 6, and 7 are 13, and 3 make 16, and I ſet down 6, and carry 1 for the 10, and go on, ſaying, 1 that I carried, and 1 are 2, which I ſet in its Place under the Line, and the Work is finiſhed: And thus I find the Sum of the aforeſaid Numbers to be 265 *l.* 9 *s.* 5 *d.* 2 *qrs.* Here is another Example in the Operation, of which the Learner muſt have an Eye to the Table of *Troy-Weight*. The Numbers given are 38 *l.* 7 *oz.* 13 *p. w.* 18 *gr.* and 50 *l.* 10 *oz.* 10 *p. w.* 12 *gr.* and 42 *l.* 08 *oz.* 05 *p. w.* 16 *gr.* And, in order to the Addition thereof, I place them as you ſee, and proceed to the Operation, ſaying, 16 and 12 are 28, and 18 are 46; now, becauſe 24 Grains make 1 Penny-weight, 46 Grains are 1 Penny-weight, and 22 Grains, therefore I ſet down 22, and carry one for the Penny-weight, and 5 make 6, and 10 are 16, and 13 are 29, which is one Ounce and 9 Penny-weights; I ſet down 9 in its Place under the Line, and carry 1 to the Ounces, ſaying, 1 that I carry, and 8 are

l.	*s.*	*d.*	*qrs.*
136	13	04	2
79	07	10	3
33	18	09	1
15	09	05	0
265	09	05	2

l.	*oz.*	*p. w.*	*gr.*
38	07	13	18
50	10	10	12
42	08	05	16
132	02	09	22

are 9; and 10 are 19, and 7 are 26, and, becauſe 26 Ounces make 2 Pounds 2 Ounces, I ſet down 2 for the Ounces, and carry 2 to the Pounds; going on, 2 that I carry and 2 are 4, and 8 make 12, that is 2 and go 1; then 1 I carry and 4 are 5, and 5 are 10, and 3 are 13, which I ſet down as in the Margin, and the Work is finiſhed, and I find the Sum of the ſaid Numbers to amount to 132 *lb.* 2 *oz.* 9 *p. w.* 22 *gr.* The Way of proving theſe, or any Sum in this Rule, is ſhewed immediately after the enſuing Example.

Addition of Engliſh Money.

l.	*s.*	*d.*	*qrs.*
436	03	05	1
184	9	10	3
784	17	04	2
584	12	10	0
1990	2	09	2

l	*s.*	*d.*	*qrs.*
48	15	11	1
76	10	07	3
18	00	05	3
24	19	09	2
168	06	10	1

Addition of Troy-Weight.

lb.	*oz.*	*p. w*	*gr.*
15	07	13	12
18	06	04	20
11	10	16	18
09	04	10	22
19	11	18	04
22	00	00	05
97	05	04	09

lb.	*oz.*	*p. w.*	*gr.*
145	09	12	18
725	08	14	10
389	97	06	15
83	10	16	20
130	00	10	12
74	07	15	00
1550	08	16	01

Addition of Apothecaries Weight.

lb.	*oz.*	*dr.*	*ſc.*	*gr.*
48	07	1	0	24
74	05	5	2	10
64	10	7	1	16
17	08	1	0	11
34	09	6	1	09
240	05	6	1	00

lb.	*oz*	*dr.*	*ſc.*	*gr.*
60	03	4	0	10
42	10	6	0	14
34	08	2	1	15
18	11	2	2	11
160	07	1	2	15
35	02	5	1	07
358	07	7	[illegible]	[illegible]

Addi-

Addition of Avoirdupoiſe Weight.

Tun.	*C.*	*qrs.*	*lb.*
75	13	1	25
48	07	3	22
60	11	1	17
21	07	0	25
22	05	0	21
218	05	0	26

lb.	*ounc.*	*dr.*
36	10	12
22	00	13
11	07	04
15	04	10
20	10	09
106	02	00

Addition of Liquid Meaſure.

Tun.	*pipes.*	*hhd.*	*gal.*
45	1	1	18
15	0	1	17
38	0	0	47
12	1	0	36
21	1	1	18
133	0	1	18

Tun.	*hhd.*	*gal.*	*pts.*
30	3	40	4
12	0	28	6
47	5	60	5
57	3	22	3
17	0	00	0
166	1	26	2

Addition of Dry Meaſure.

Chal.	*qrs.*	*buſh.*	*pec.*
48	3	7	3
13	1	4	0
54	0	6	2
16	3	6	1
4	1	0	1
137	3	0	3

qrs.	*buſh.*	*pec.*	*gal.*
17	3	1	1
50	1	3	0
14	5	3	1
40	2	0	1
30	0	3	0
152	5	3	1

Addition of Long Meaſure.

Yds.	*qrs.*	*Nails.*
35	3	3
14	1	2
74	2	3
38	0	1
30	1	0
15	0	0
208	1	1

Ells.	*qrs.*	*Nails.*
56	1	3
13	3	2
48	2	3
50	0	0
74	2	2
17	1	1
260	1	0

Addition of Land Meaſure.

Acre.	*Rood.*	*Perch.*	*Acre.*	*Rood.*	*Perch.*
12	3	18	86	1	36
14	0	24	47	3	24
30	2	19	73	2	28
48	3	30	60	1	07
28	1	38	04	2	08
50	3	26	14	0	14
185	3	35	286	3	37

The Proof of Addition.

6. *Addition* is proved after this Manner: When you have found out the Sum of the Number given, then ſeparate the uppermoſt Line from the reſt, with a Stroke or Daſh of the Pen, and then add them all up again, as you did before, leaving out the uppermoſt Line; and, having ſo done, add the new invented Sum to the upper Line you ſeparated, and if the Sum of thoſe two Lines be equal to the Sum firſt found out, then the Work is performed true, otherwiſe not. As for Example: Let us prove the firſt Example of *Addition of Money*, whoſe Sum we find to be 265 *l.* 9 *s.* 5 *d.* 2 *qrs.* and which we prove thus: Having ſeparated the uppermoſt Number from the reſt by a Line, as you ſee in the Margin, then I add the ſame together again, leaving out the ſaid uppermoſt Line, and the Sum thereof I ſet under the firſt Sum or true Sum; which doth amount to 128 *l.* 16 *s.* 10 *d.* 0 *qrs.* then again I add the new Sum to the uppermoſt Line that before was ſeparate from the reſt, and the Sum of thoſe two is 265 *l.* 09 *s.* 05 *d.* 2 *qrs.* the ſame with the firſt Sum, and therefore I conclude that the Operation was rightly performed.

l.	*s.*	*d.*	*qrs.*
136	13	04	2
79	07	10	3
33	18	09	1
15	09	05	0
265	09	05	2
128	16	10	0
265	09	05	2

7. The main End of *Addition*, in Queſtions reſolvable thereby, is to know the Sum of ſeveral Debts, Parcels, Intereſts, &c. The Queſtions may be theſe that follow.

Queſt. 1. There was an old Man whoſe Age was required, which he replied, I have 7 Sons, having two Years beween the Birth of each other, and in the 44th Year of my ge my eldeſt Son was born, which is now the Age of the oungeſt. I demand, What was the old Man's Age?

Now, to reſolve this Queſtion, firſt ſet down the Faer's Age at the Birth of his firſt Child, which was 4; then the Difference between the Oldeſt and the oungeſt, which is 12 Years, and then the Age of the oungeſt, which is 44; and then add them all toger, and their Sum is 100, the complete Age of their ther.

44
12
44
——
100

Queſt. 2. A Man lent his Friend, at ſeveral Times, theſe eral Sums, *viz.* at one Time 63 *l.* at another Time 50 *l.* another Time 48 *l.* at another Time 156 *l.* Now I dee to know how much was lent him in all?

Set the Sums lent one under another, as you ſee in Margin, and then add them together, and you will d their Sum to amount to 317 *l.* which is the Total all the ſeveral Sums lent, and ſo much is due to the editor.

63
50
48
156
——
317

Queſt. 3. There are two Numbers, the leaſt whereof is 4, and their Difference 14. I deſire to know at is the greateſt Number, and alſo what the Sum of them both? Firſt ſet down the ſt, *viz.* 40 and 14, the Difference, and add m together, and their Sum is 54 for the ateſt Number; then I ſet 40 (the leaſt) un- 54 (the greateſt) and add them together, their Sum is 94, equal to the greateſt and t Numbers.

40
14
—
greateſt 54
leaſt 40
—
Sum 94

CHAP. V.

Of Subtraction of whole Numbers.

S*Ubtraction* is taking of a leſſer Number out of a greater of a like Kind, whereby to find out a third Number, being or declaring the Inequality, Exceſs, or Difference between the Numbers given; or *Subtraction* is that by which one Number is taken out of another Number given, to the End that the Reſidue or Remainder may be known, which Remainder is alſo called the Reſt, Remainder, or Difference of the Numbers given.

2. The Number out of which *Subtraction* is to be made muſt be greater, or at leaſt equal with the other Number given; the higher Number is called the *Major*, and the lower, *Minor*; and, the Operation of *Subtraction* being finiſhed, the Reſt or Remainder is called the *Difference* of the Number given.

3. In *Subtraction*, place the Numbers given reſpectively, the one under the other, in ſuch Sort as like Degrees, Places, or Denominations may ſtand in the ſame Series, *viz.* Units under Units, Tens under Tens, Pounds under Pounds, &c. Feet under Feet, and Parts under Parts, &c. This being done, draw a Line underneath, as in *Addition*.

Having placed the Numbers given, as is before directed, and drawn a Line under them, ſubtract the lower Number (which in this Caſe muſt always be leſs than the Uppermoſt) out of the higher Number, and ſubſcribe the Difference or Remainder reſpectively below the Line, and, when the Work is finiſhed, the Number below the Line will give you the Remainder.

As for Example, Let 364521 be given to be ſubtracted from 795836, I ſet the leſſer under the greater as in the Margin, and draw a Line under them; then beginning at the right Hand, I ſay, 1 out of 6 and there remains 5, which I ſet in Order under the Line; then I proceed to the next, ſaying, 2 from 3 reſts 1, which I note alſo under the Line, and thus I go on till I have finiſhed the

$$\begin{array}{r} 795836 \\ 364521 \\ \hline 431315 \end{array}$$

Work ; and then I find the Remainder or Difference to be 431315.

5. But if it ſo happen (as commonly it doth) that the lowermoſt Number or Figure is greater than the uppermoſt, then in this Caſe add ten to the uppermoſt Number, and ſubtract the ſaid lowermoſt Number from their Sum, and the Remainder place under the Line ; and, when you go to the next Figure below, pay an Unit, by adding it thereto for the ten you borrowed before, and ſubtract that from the higher Number of Figures, and thus go on till your Subtraction be finiſh'd. As for Example, Let 437503 be given, from whence it is required to ſubtract 153827 ; I diſpoſe of the Numbers as is before directed, and as you ſee in the Margin ; then I begin, ſaying, 7 from 3 I cannot, but (adding 10 thereto) I ſay 7 from 13, and there remain 6, which I ſet down under the Line in Order ; then I proceed to the next Figure ſaying, 1 that I borrowed and 2 is 3 from 0 I cannot, but 3 from 10 and there remain 7, which I likewiſe ſet down as before ; then 1 that I borrowed and 8 is 9 from 5 I cannot, but 9 from 15 and there remain 6 ; then 1 I borrowed and 3 is 4 from 7, and there remain 3 ; then 5 from 3 I cannot, but 5 from 13 and there remain 8 ; then 1 I borrowed and 1 are 2, from 4, and there reſt 2 ; and thus the Work is finiſhed : After theſe Numbers are ſubtracted one from another, the Inequality, Remainder, Exceſs, or Difference, is found to be 283676. Examples for your farther Experience may be theſe that follow :

437503
153827
———
283676

From	3469916	From	361577
Take	738642	Take	5864
Reſt	2731274	Reſt	355713

6. If the Sum or Number to be ſubtracted is of ſeveral Denominations, place the leſſer Sum below the greater, and in the ſame Rank and Order, as is ſhewed in Addition of the ſame Numbers ; then begin at the right Hand, and take the lower Number out of the uppermoſt, if it be leſſer ; but, if it be bigger than the uppermoſt, then borrow an Unit from the next greater Denomination, and

turn it into the Parts of the leſs Denomination, and add thoſe Parts to the Uppermoſt, noting the Remainder below the Line; then proceed and pay one to the next Denomination for that which you borrowed before, and proceed in this Order till the Work be finiſhed. An Example of this Rule followeth: Let 375 *l.* 13 *s.* 7 *d.* 1 *qr.* be given, from whence let it be required to ſubtract 57 *l.* 16 *s.* 03 *d.* 2 *qr.* In order whereunto, I place the Numbers as you ſee in the Margin; and thus I begin at the leaſt Denomination, ſaying, 2 from 1 I cannot, therefore I borrow one Penny from the next Denomination, and turn it into Farthings, which is 4, and adding 4 to 1, whis is 5, I ſay, but 2 from 5, and there remain 3, which I put under the Line; then going on, I ſay, 1 that I borrowed and 3 is 4 from 7, and there reſt 3; then going on, I ſay, 16 from 13 I cannot, but borrowing 1 Pound, and turning it into 20 Shillings, I add to it 13, and that is (33) wherefore I ſay, 16 from 33 and there remains 17, which I ſet under the Line, and go on; ſaying, 1 that I borrow'd and 7 is 8, from 5 I cannot, but 8 from 15, and there remain 7; and the 1 that I borrowed and 5 is 6, from 7 there reſts 1, and 0 from 3 reſt 3, and the Work is done. And I find the Remainder or Difference to be 317 *l.* 17 *s.* 03 *d.* 3 *qrs.*

l.	*s.*	*d.*	*qr.*
375	13	07	1
57	16	03	2
317	17	03	3

Another Example of *Troy-weight* may be this: I would ſubtract 17 *l.* 10 *oz.* 11 *p. w.* 20 *gr.* from 24 *l.* 5 *oz.* 00 *p. w.* 08 *gr.* I place the Numbers according to the Rule, and begin, ſaying 20 from 8 I cannot, but I borrow 1 Penny-weight, which is 24 Grains, and add them to 8, and there are 32, wherefore I ſay 20 from 32 reſt 12: then 1 that I borrowed and 11 is 12 from 00 I cannot, but 12 from 20 (borrowing an Ounce, which is 20 Penny-weights, and there remain 8; that 1 that I borrowed and 10 is 11, from 5 I cannot, but 11 from 17, and there reſt 6; then 1 that I borrowed, and 7 is 8, from 4 I cannot, but 8 from 14 and

l.	*oz.*	*p.w.*	*gr.*
24	05	00	08
17	10	11	20
06	06	08	12

and there reſt 6; then 1 that I borrowed and 1 is 2 from 2, and there reſts nothing; ſo that I find the Remainder or Difference to be 6 *l.* 6 *oz.* 8 *p. w.* 12 *gr.*

7. It many times happeneth that you have many Sums or Numbers to be ſubtracted from one Number; as ſuppoſe a Man ſhould lend his Friend a certain Sum of Money, and his Friend hath paid him Part of his Debt at ſeveral Times, then, before you can conveniently know what is ſtill owing, you are to add the ſeveral Numbers or Sums of Payment together, and ſubtract their Sum from the whole Debt, and the Remainder is the Sum due to the Creditor; as ſuppoſe A lendeth to B 564 *l.* 16 *s.* 10 *d.* and B hath repaid him 76 *l.* 16 *s.* 8 *d.* at one Time, 163 *l.* 18 *s.* 11 *d.* at another Time, and 241 *l.* 15 *s.* 8 *d.* at another Time; and you would know how the Accompt ſtandeth between them, or what is more due to A. In order whereunto I firſt ſet down the Sum which A lent, and draw a Line underneath it; the under that Line I ſet then ſeveral Sums of Payment, as you ſee in the Margin; and, having brought the ſeveral Sums of Payment into one Total by the 5th Rule of the fourth Chapter foregoing, I find the Sum amounteth to 482 *l.* 11 *s.* 3 *d.* which I ſubtract from the Sum firſt lent by A, by the 6th Rule of this Chapter, and I find the Remainder to be 82 *l.* 5 *s.* 7 *d.* and ſo much is ſtill owing to A

	l.	*s.*	*d.*
Lent	564	16	10
Paid at ſeveral Payments.	76	16	08
	163	18	11
	241	15	08
Paid in all	482	11	03
Remain	82	05	07

When the Learner hath good Knowledge of what hath been already delivered in this and the foregoing Chapters, he will, with Eaſe, underſtand the Manner of working the following Examples:

Subtraction of whole Numbers.

	l.	*s.*	*d.*	*l.*	*s.*	*d.*	*qrs.*
Borrowed	374	10	3	700	10	11	2
Paid	79	15	11	6	01	19	2
Remain	294	14	04	694	06	11	3

	l.	*s.*	*d.*
Borrowed	1000	00	00
Paid	19	00	06
Remain	980	19	6

l.	*s.*	*d.*	*qrs.*
711	03	00	1
11	13	00	3
699	09	11	1

	l.	*s.*	*d.*	*qrs.*
Borrowed	3300	00	00	0
Paid at ſeveral Payments	170	10	00	0
	361	13	10	1
	590	03	04	3
	73	04	11	3
Paid in all	1195	12	02	3
Remained due	2104	07	09	1

Subtraction of Troy-weight.

	lb.	*oz.*	*p. w.*	*gr.*
Bought	174	00	13	00
Sold	78	04	16	15
Remain	95	07	16	09

	lb.	*oz.*	*p. w.*	*gr.*
Bought	470	10	14	14
Sold at ſeveral Times	60	00	00	00
	35	10	18	00
	16	07	09	08
	48	04	00	00
	61	11	19	23
	23	00	00	00
Sold in all	245	10	07	07
Remain unſold	225	00	05	07

Subtraction of Apothecaries Weight.

	lb.	*oz.*	*dr.*	*ſc.*	*gr.*
Bought	12	04	3	0	00
	8	05	1	1	15
Remain	03	11	1	1	05

lb.	*oz.*	*dr.*	*ſc.*	*gr*
20	06	1	0	0
10	06	1	2	1
09	11	7	0	1

Subtracti

Subtraction of Avoirdupoiſe-weight.

	C.	*qrs.*	*lb.*		*tu.*	*C.*	*qrs.*	*lb.*	*oz.*	*dr.*
Bought	35	0	15		5	07	1	10	10	15
Sold	16	2	20		3	17	1	16	09	13
Remain	18	1	23		1	17	3	22	01	02

Subtraction of Liquid-Meaſure.

	tu.	*hhd.*	*gal.*		*tu.*	*hhd.*	*gal.*	*pints.*
Bought	40	1	30		60	3	42	4
Sold	16	1	40		15	3	46	6
Remain	23	3	53		44	3	58	6

Subtraction of Dry Meaſure.

	chal.	*qrs.*	*buſh.*	*pec.*		*chal.*	*qrs.*	*buſh.*	*pec.*
Bought	100	0	0	0		73	2	2	2
Sold	54	1	4	3		46	2	3	1
Remain	45	2	3	1		26	3	7	1

Subtraction of Long Meaſure.

	yds.	*qrs.*	*nls.*		*yds.*	*qrs.*	*nls.*
Bought	160	0	0		344	0	1
Sold	64	1	2		177	1	3
Remain	95	2	2		166	2	2

Subtraction of Land Meaſure.

	acres.	*rood.*	*perch.*		*acres.*	*rood*	*perch.*
Bought	140	2	13		600	0	00
Sold	70	3	12		54	0	16
Remain	69	3	01		545	3	24

The Proof of Subtraction.

8. When your Subtraction is ended, if you deſire to prove the Work, whether it be true or no; then add the Remainder to the minor Number, and, if the Aggregate or theſe two be equal to the major Number, then is your Operation true, otherwiſe falſe: Thus let us prove the firſt Example of the fifth Rule of this Chapter; where, after, Subtraction is ended, the Numbers ſtand as in the Margin

the Remainder or Difference between 283676. Now, to prove the Work, I add the ſaid Remainder 283676 to the Minor Number 153827 by the fourth Rule of the foregoing Chapter, and I find the Sum or Aggregate to be 437503, equal to the major Number, or Number from whence the leſſer is ſubtracted. Behold the Work in the Margin.

437503
153827
283676
437503

The Proof of another Example may be the firſt of the 6th Rule of this Chapter, where it is required to ſubtract 57 *l.* 16 *s.* 3 *d.* 2 *qrs.* from 375 *l.* 13 *s.* 7 *d.* 1 *qr.* and by the Rule I find the Remainder to be 317 *l.* 17 *s.* 3 *d.* 3 *qrs.* Now to prove it I add the ſaid Remainder 317 *l.* 17 *s.* 3 *d.* 3 *qrs.* to the minor Number 57 *l.* 16 *s.* 3 *d.* 2 *qrs.* and their Sum is 375 *l.* 13 *s.* 7 *d.* 1 *qr.* equal to the major Number, which proves the Work to be true; but, if it had happened either to have been more or leſs than the ſaid major Number, then the Operation had been falſe.

l.	*s.*	*d.*	*qrs.*
375	13	07	1
57	16	03	2
317	17	03	3
375	13	07	1

9. The general Effect of Subtraction is to find the Difference or Exceſs between to Numbers, and the Reſt when a Payment is made in Part of a greater Sum, the Date of Books printed, the Age of any Thing, by knowing the preſent Year, and the Year wherein they are made, created, or built, and ſuch like.

The Queſtions, appropiated to the Rule, are ſuch as follow.

Queſt. 1. What Difference is there between one Thing of 125 Feet long, and another of 66 Feet long?

To reſolve this Queſtion, Firſt I ſet down the major or greater Number 125, and under it the minor or leſſer Number 66, as is directed in the third Rule of this Chapter, and, according to the fourth Rule of the ſame, I ſubtract the Minor from the Major, and the Remainder, Exceſs, or Difference I find to be 59. See the Work in the Margin.

125
66
59

Queſt. 2. A Gentleman ow'd a Merchant 365 *l.* whereof he hath paid 278 *l.* what more doth he owe?

To give an Anſwer to this Queſtion, I firſt ſet down the major Number 365 *l.* and under it I place 278 the minor, and ſubtract the one from the other, whereby I diſcover the Exceſs, Difference, or Remainder, to be 87; and ſo much is ſtill due to the Creditor, as *per* Margin.

365
278
———
87

Queſt. 3. An Obligation was written, a Book printed, a Child born, a Church built, or any other Thing made in the Year of our Lord 1572, and now we account the Year of our Lord 1750, the Queſtion is to know the Age of the ſaid Things; that is, How many Years are paſſed ſince the ſaid Things were made? I ſay, if you ſubtract the leſſer Number 1572 from the greater 1750, the Remainder will be 175, and ſo many Years are paſſed ſince the Making of the ſaid Things, as by the Work in the Margin.

1750
1572
———
178

Queſt. 4. There are three Towns lie in a ſtrait Line, *viz.* *London*, *Huntingdon*, and *York*; now the Diſtance between the fartheſt of the Towns, *viz.* *London* and *York*, is 151 Miles, and from *London* to *Huntingdon* is 49 Miles; I demand how far it is from *Huntingdon* to *York*?

To reſolve this Queſtion, ſubtract 49 the Diſtance between *London* and *Huntingdon*, from 151, the Diſtance between *London* and *York*, and the Remainder is 102, for the true Diſtance between *Huntingdon* and *York*. See the Work in the Margin.

151
49
———
102

CHAP. VI.

Of Multiplication of whole Numbers.

MUltiplication is perform'd by two Numbers of like Kind, for the Production of a Third, which ſhall have ſuch Reaſon to the one, as the other hath to the Unit, and in Effect is a moſt brief and artificial Compound Addition of many equal Numbers of the like Kind into one Sum. Or, Multiplication is that by which we multiply two or more Numbers, the one into the other, to the End that their Product may come forth, or be diſcovered.

Or, *Multiplication* is the Increaſing of any one Number by any other, ſo often as there are Units in that Number, by which the other is increaſed; or by having two Numbers given to find a Third, which ſhall contain one of the Numbers as many times as there are Units in the other.

2. *Multiplication* hath three Parts. Firſt, the Multiplicand, or Number to be multiplied. Secondly, the Multiplier, or Number given by which the Multiplicand is to be multiplied. And thirdly, the Product or Number produced by the other two, the one being multiplied by the other; as if 8 were given to be multiplied by 4, I ſay 4 times 8 is 32; here 8 is the Multiplicand, and 4 is the Multiplier, and 32 is the Product.

8
4
—
32

3. *Multiplication* is either *Single*, by one Figure; or *Compound*, that conſiſteth of many.

Single Multiplication is ſaid to conſiſt of one Figure, becauſe the Multiplicand and Multiplier conſiſt each of them of a Digit, and no more; ſo that the greateſt *Product* that can ariſe by *Single Multiplication* is 81, being the Square of 9; and *Compound Multiplication* is ſaid to conſiſt of many Figures, becauſe the Multiplicand or Multiplier conſiſts of more Places than one; as if we were to multiply 436 by 9: it is called Compound, becauſe the Multiplicand 436 is of more Places than one, *viz.* 3 Places.

4. The Learner ought to have all the Varieties of *Single Multiplication* by Heart, before he can well proceed any farther into this Art; it being of moſt excellent Uſe, and none of the following Rules in *Arithmetick*, but what have a principal Dependence thereupon, which may be learnt by the following Table.

Multiplication TABLE.

1	2	3	4	5	6	7	8	9
2	4	6	8	10	12	14	16	18
3	6	9	12	15	18	21	24	27
4	8	12	16	20	24	28	32	36
5	10	15	20	25	30	35	40	45
6	12	18	24	30	36	42	48	54
7	14	21	28	35	42	49	56	63
8	16	24	32	40	48	56	64	72
9	18	27	36	45	54	63	72	81

The Uſe of the proceding Table is this: In the uppermoſt Line or Column, you have expreſſed all the Digits from 1 to 9; and likewiſe beginning at 1, and going downwards in the Side Column, you have the ſame; ſo that, if you would know the Product of any two ſingle Numbers multiplied by one another, look for one of them, which you pleaſe, in the uppermoſt Column, and for the other in the Side Column; and running your Eye from each Figure along the reſpective Columns in the common Angle or Place, where theſe two Columns meet, there is the Product required. As for Example, I would know how much is 8 times 7: Firſt, I look for 8 in the uppermoſt Column, and 7 in the Side Column; then I do caſt my Eye from 8 along the Column downwards from the ſame, and likewiſe from 7 in the Side Column I caſt my Eye from thence toward the right Hand, and find it to meet with the firſt Column at 56, ſo that I conclude 56 to be the Product required, *&c.*

5. In Compound Multiplication, if the Mnltiplicand conſiſts of many Places and the Multiplier of but one Figure; firſt ſet down the Multiplicand, and under it place the Multiplier in the Place of Units, and draw a Line underneath them; begin then, and multiply the Multiplier into every particular Figure of the Multiplicand, beginning at the Place of Units, and ſo proceed towards the left Hand, ſetting each particular Product under the Line, in order as you proceed; but if any of the Products exceed

ceed 10, or any Number of Tens, ſet down the Exceſs, and for every 10 carry an Unit to be added to the next Product, always remembring to ſet down the total Product of the laſt Figure; which Work being finiſhed, the Sum or Number placed under the Line ſhall be the true and total Product required. As for Example, I would multiply 478 by 6: Firſt ſet down 478, and underneath it 6, in the Place of Units, and draw a Line underneath them, as in the Margin; then I begin, ſaying, 6 times 8 is 48, which is 8 above 4 Tens, therefore I ſet down 8 (the Exceſs) and bear 4 in Mind for the 4 Tens; then I proceed, ſaying, 6 times 7 is 42 and 4 that I carried is 46; I then ſet down 6 and carry 4, and go on, ſaying, 6 times 4 is 24, and 4 that I carried is 28, and, becauſe it is the laſt Figure, I ſet it all down and ſo the Work is finiſhed, and the Product is found to be 2868, as was requir'd

$$\begin{array}{r}478\\6\\\hline 2868\end{array}$$

6. When, in Compound Multiplication, the Multiplier conſiſteth of divers Places, then begin with the Figure in the Place of Units in the Multiplier, and multiply it into all the Figures of the Multiplicand, placing the Product below the Line, as was directed in the laſt Example; then begin with the Figure of the ſecond Place of the Multiplier, *viz.* The Place of Tens, and multiply it likewiſe into the whole Multiplicand (as you did the firſt Figure) placing its Product under the Product of the firſt Figure; do in the ſame Manner by the Third, Fourth and Fifth, *&c.* until you have multiplied all the Figures of the Multiplier particularly into the whole Multiplicand, ſtill placing the Product of each particular Figure under the Product of its preceding Figure; herein obſerving the following Caution.

A Caution.

In the placing of the Product of each particular Figure of the Multiplier, you are not to follow the 2d Rule of the 4th Chapter, *viz.* to place Units under Units, and Tens under Tens, *&c.* but to place the Figure or Cypher into the Place of Units of the ſecond Line under the ſecond Figure or Place of Tens in the Line above it, and the Figure or Cypher in the Place of Units in the third Line under the Place of Tens in the ſecond Line, *&c.* obſerving this Order till you ou have finiſhed the Work, ſtill placing the Figure of every Line or Product under the ſecond Figure or Place of Tens in that which was above it, and, having ſo done, draw a Line under all theſe particular Products, and add them together; ſo ſhall the Sum of the Products be the total Product required.

As if it were required to multiply 764 by 27, I ſet them down the one under the other, with a Line drawn underneath them; then I begin, ſaying 7 times 4 is 28, then I ſet down 8, and carry 2; then I ſay, 7 times 6 is 42, and 2 that I carried is 44, that is 4 and go 4; then 7 times 7 is 49, and 4 that I carry is 53, which I ſet down, becauſe I have not another Figure to multiply; thus I have done with the 7; then I begin with the 2, ſaying 2 times 4 is 8, which I ſet down under 4, the ſecond Figure or Place of Tens in the Line above it, as you may ſee in the Margin; then I proceed, ſaying, 2 times 6 is 12, that is 2 and carry 1; then 2 times 7 is 14, and 1 that I carry is 15, which I ſet down, becauſe it is the Product of the laſt Figure; ſo the Product of 764 by 7 is 5348, and by 2 is 1528, which being placed the one under the other, as before directed, as you ſee in the Margin, and a Line drawn under them, and they added together reſpectively, make 20628, the true Product required, being equal to 27 times 764.

$$\begin{array}{r}
764 \\
27 \\
\hline
5348 \\
1528 \\
\hline
20628
\end{array}$$

Another Example may be this: Let it be required to multiply 5486 by 465; I diſpoſe of the Multiplicand and Multiplier according to the Rule, and begin multiplying the firſt Figure of the Multiplier, which is (5) into the whole Multiplicand, and find the Product is 27430; then I proceed, and multiply the ſecond Figure (6) of the Multiplier into the Multiplicand, and find the Product to amount to 32916, which is ſubſcribed under the other Product reſpectively; then do I multiply the third and laſt Figure (4) of the Multiplier into the Multiplicand, and the Product is 21944, which is likewiſe placed under the ſecond Line reſpectively; then I draw a Line under the ſaid Product (being placed the one under the

$$\begin{array}{r}
5486 \\
465 \\
\hline
27430 \\
32916 \\
21944 \\
\hline
2550990 \\
\hline
\end{array}$$

the other according to Rule) and add them together, and the Sum is 2550990, the true Product ſought, being equal to 5486 times 465, or 465 times 5486.

More Examples in this Rule are theſe following:

430865
4739

3877785
1292595
3016055
1723460

2041869235

6400758
37496

38404548
57606822
25603032
44805306
19202274

240002821968

Compendium in Multiplication.

7. Although the former Rules are ſufficient for all Caſes in *Multiplication*, yet, becauſe in the Work of *Multiplication* many times great Labour may be ſaved, I ſhall acquaint the Learner with ſome Compendiums, in order thereunto, *viz.* If the Multiplicand or Multiplier, or both of them, end with Cyphers, then in your Multiplying you may neglect the Cyphers, and multiply only the ſignificant Figures, and to the Product of thoſe ſignificant Figures add ſo many Cyphers as the Numbers given to be multiplied did end with; that is, annex them on the right Hand of the ſaid Product, ſo ſhall that give you the true Product required. As if I were to multiply 32000 by 4300, I ſet them down, in order to be multiplied, as you ſee in the Margin; but, neglecting the Cyphers in both Numbers, I only multiply 32 by 43, and the Product I find to be 1376; to which I annex the 5 Cyphers in the Multiplicand and Multiplier,

Si numeris propoſitis unus vel uterque adjunctos habeat ad dextram circulos, omiſſis circulis, fiat ipſorum numerorum multiplicatio, & facto demum tot inſuper integrorum loci accenſeantur quot ſunt omiſſi circuli in utroque factore. Clavis Mat. c. 4. 3.

32000
4300

96
128

137600000

nd then it makes 137600000 for the true Product of 2000 by 4300.

8. If in the Multiplier Cyphers are placed between ignificant Figures, then multiply only the ſignifi-ant Figures, neglecting the Cyphers; but here ſpecial Care muſt be taken in the rue Placing of the firſt Figure, after the Neglect of ſuch Cypher or Cyphers; and herefore you muſt obſerve in what Place of the Multiplier the Figure you multiply by ſtandeth, and ſet the firſt Figure of the Product under the ſame Place of the Product of the ſame Figure of your Multiplier: As for Example, Let it be required to multiply 371568 by 0007. Firſt, I multiply the Multiplicand by 7, and the Product is 2600976; then, neglecting the Cyphers, I multiply by 4, and that Product is 1486272; now I conſider, that 4 is the 5th Figure, in the Multiplier, therefore I place 2 (the firſt Figure of the Product by 4) under the 5th Place of the firſt Product by 7, and the reſt in Order, and, having added them together, the Total Product is found to be 14865320976. Other Examples in this Rule are theſe following:

Si intermedio multiplicantis loco circulus fuerit, ille negligitur, Alſted. c. 6, *De Arithm.*

```
      371568
       40007
 -----------
     2600976
  1486272...
 -----------
 14865320976
```

```
     32786
      6030
 ----------
   9827580
 1965516
 ----------
 1975343589
```

```
      7864371
        20604
 ------------
     31457484
   47186226.
 15728742.
 ------------
 162037500084
```

9. If you are to multiply any Number by an Unit with Cyphers, as by 10, 100, 1000, &c. then annex ſo many Cyphers before the Multiplicand, and that Number, when the Cyphers are annexed, is the Product required. As if you would multiply 428 by 100, annex 2 Cyyhers to 428, and it is 42800. If it were required to multiply 100 by 100000,

10000, annex 4 Cyphers and it gives 1000000 for the Product required,

The Proof of Multiplication.

10. *Multiplication* is proved by *Diviſion*, and, to ſpeak Truth, all other Ways are falſe (according to *Friſius*) and therefore it will be neceſſary in the firſt Place to learn *Diviſion*, and by that to prove *Multiplication*. There are ſome other Ways uſed indeed, but, on a ſtrict Examen, there is not one in a Thouſand of their Products right; therefore I omit them.

11. The general Effect of *Multiplication* is contained in the Definition of the ſame, which is to find out a third Number, ſo often containing one of the two given Numbers, as the other containeth Units.

The ſecond Effect is, by having the Length and Breadth of any Thing (as a Parallelogram or long Plane) to find the ſuperficial Content of the ſame, and by having the ſuperficial Content of the Baſe, and the Length, to find out the Solidity of any Parrallelopipedon, Cylinder, or other ſolid Figures.

The third Effect is, by the Contents, Price, Value, Buying, Selling, Expence, Wages, Exchange, Simple Intereſt, Gain or Loſs of any one Thing, be it Money, Merchandize, &c. to find out the Value, Price, Expence, Buying, Selling, Exchange, or Intereſt of any Number of Things of the like Name, Nature, and Kind.

The fourth Effect is (not much unlike the other) by the Contents, Value, or Price of any one Part of any Thing denominated, to find the Contents, Value, or Price of the whole Thing, all the Parts into which the whole is divided, multiplying the Price of one of thoſe Parts.

The fifth Effect is, to aid, to compound, and to make other Rules, as chiefly, the *Rule of Proportion*, called the *Golden Rule*, or *Rule of Three*; alſo by it Things of one Denomination are reduced to another.

If you multiply any Number of Integers, to the Price of the Integer, the Product will diſcover the Price of the Quantity, or Number of Integers given.

In a Rectangular Solid, if you multiply the Breadth of the Baſe by the Depth, and that Product by the Length, the laſt Product will diſcover the Solidity or Content of the ſame Solid.

Some

ome Queſtions proper, to this Rule, may be theſe following:

Queſt. 1. What is the Content of a ſquare Piece of Ground, whoſe Length is 28 Perches, and Breadth 13?

Anſw. 364 ſquare Perches; for multiplying 28 the Length by 13 the Breadth, the Product is ſo much.

Queſt. 2. There is a ſquare Battle whoſe Flank is 47 Men, and the Files 19 deep, what Number of Men doth hat Battle contain? *Facit*, 893; for, multiplying 47 by 19, he Product is 863.

Queſt. 3. If any one Thing coſt 4 Shillings, what ſhall 9 Things coſt? *Anſw.* 36 Shillings, for, multiplying 4 by 9, he Product is 36.

Queſt. 4. If a Piece of Money or Merchandize be worth or coſt 17 Shillings, what ſhall 19 ſuch Pieces of Money or Merchandize coſt? *Facit*, 323 Shillings, which is equal o 16 *l.* 3 *s.*

Queſt. 5. If a Soldier or Servant get or ſpend 14 *s. per* Month, what is the Wages or Charges of 49 Soldiers or Servants for the ſame Time? Multiply 49 by 14, the Product is 686 *s.* or 34 *l.* 6 *s.* for the Anſwer.

Queſt. 6. If in a Day there are 24 Hours, how many Hours are there in a Year, accounting 365 Days to conſtitute the Year? *Facit*, 8760 Hours, to which if you add he 6 Hours over and above 365 Days, as there are in a Year, then it will be 8766 Hours; now if you multiply this 8766 by 60, the Number of Minutes in an Hour, it will produce 525960, the Number of Minutes in a Year.

CHAP. VII.

Diviſion of Whole Numbers.

. D*IVISION* is the ſeparating or parting of any Number or Quantity given into any Part aſſigned, r to find how often one Number is contained in another; r, from any two Numbers given, to find a third that ſhall onſiſt of ſo many Units, as the one of thoſe two Numbers iven is comprehended to contain in the other.

2. *Diviſion* hath three Parts or Numbers remarkable, *iz.* Firſt, the Dividend; 2dly, The Diviſor, 3dly,

The Quotient, The Dividend is the Nnmber given to be parted or divided. The Divſor is the Number given, by which the Dividend is divided, or it is the Number which ſheweth how many Parts the Dividend is to be divided into. And the Quotient is the Number produced by the Diviſion of the two given Numbers the one by the other.

So 12 being given to be divided by 3, or into three equal Parts, the Quotient will be 4; for 3 is contained in 12 four times, where 12 is the Dividend, and 2 is the Diviſor, and 4 is the Quotient.

3. In Diviſion ſet down your Dividend, and draw a crooked Line at each End of it, and before the Line at the left Hand place the Diviſor, and behind that on the right Hand place the Figures of the Quotient, as in the Margin, where it is required to divide 12 by 3; 3) 12 (4 Firſt, I ſet down 12 the Dividend, and on each Side of it I draw a crooked Line, and before that on the left Hand do I place 3 the Diviſor; then do I ſeek how often 3 is containd in 12, and, becauſe I find it four times, I put 4 before the crooked Line, on the right Hand of the Dividend, denoting the Quotient.

4 But if, when the Diviſor is a ſingle Figure, the Dividend conſiſteth of two or more Places, then having placed them for the Work, as before directed, put a Point under the firſt Figure of the left Hand of the Dividual, provided it be bigger than, or equal to the Diviſor; but, if it be leſſer than the Diviſor, then put a Point under the ſecond Figure from the left Hand of the Dividend; which Figures, as far as the Point goeth from the left Hand, are to be reckon'd by themſelves, as if they had no Dependance upon the other Part of the Dividend: And for Diſtinction ſake may be call'd the Dividual; then aſk how often the Diviſor is contained in the Dividual, placing the Anſwer in the Quotient; then multiply the Diviſor by the Figure that you placed in the Quotient, and ſet the Product thereof under your Dividual; then draw a Line under the Product, and ſubtract the ſaid Product from the Dividual, placing the Remainder under the ſaid Line; then put a Point under the next Figure in the Dividend, on the right Hand of that to which you put the Point before, and

w it down, placing it on the right Hand of the Remain- which you found by Subtraction; which Remainder, h the ſaid Figure annexed before it, ſhall be a new Di- ual; then ſee again how often the Diviſor is contained this new Dividual, and put the Anſwer in the Quotient the right Hand of the Figure which you put there be- e; then multiply the Diviſor by the laſt Figure that you in the Quotient, and ſubſcribe the Product under the vidual, and make Subtraction, and to the Remainder w down the next Figure from the grand Dividend (ha- g firſt put a Point under it) and put it on the right Hand the Remainder for a new Dividual as before, and pro- d thus till the Work is finiſhed.

Obſerving this general Rule in all Kinds of *Diviſion:* ſt, to ſeek how often the Diviſor is contained in the vidual; then, having put the Anſwer in the Quotient, ltiply the Diviſor thereby, and ſubtract the Product m the Dividual. An Example or two will make the le plain. Let it be required to divide 2184 by 6. I poſe of the Numbers given as is before directed, and as ſee in the Margin, in order to the rk; then, becauſe 6 the Diviſor is more n 2, the firſt Figure of Dividend, I a Point under 1, the ſecond Figure, ich makes the 21 for the Dividual; then do I aſk how n 6 the Diviſor is contained in 21, and, becauſe I can- have it more than 3 times, I put 3 he Quotient, and thereby do I multiply Diviſor (6) and the Product is 18, ich I ſet in Order under the Dividual, ſubtract it therefrom, and the Re- inder (3) I place in Order under the e as you ſee in the Margin.

6) 2184 (3

6) 2184 (3

———

3

6) 2184 (36

18

———

38

36

———

2

Then do I make a Point under the next ure of the Dividend, being 8, and w it down, placing it before the Re- inder 3, and ſo have I 36 for a new Divi- l; then do I ſeek how often 6 is con- ed in 38, and, becauſe I can't have it re than 6 times, I put 6 in the Quo- t, and thereby do I multiply the Diviſor, 6, and the

Product 36, I put under the Dividual 38, and ſubtract it therefrom, and the Remainder 2 I put under the Line, as you ſee in the Margin.

Then I do put a Point under the next and laſt Figure of the Dividend, being 4, and draw it down to the Remainder 2, and, putting it on the Right Hand thereof, it maketh 24 for a new Dividual; then I aſk how often 6 is contained in 24, and the Anſwer is 4, which I put in the Quotient, and multiply the Diviſor 6 thereby, and the Product 24 I put under the Dividual 24, and ſubtract it therefrom, and the Remainder is 0; and thus the Work is finiſhed, and I find the Quotient to be 364, that is, 6 contained in 2184 juſt 364 times, or, 2184 divided into 6 equal Parts, 364 is one of thoſe Parts.

```
6) 2184 (364
    ...
   18
   --
    38
    36
    --
     24
     24
     --
      0
```

Again, If it were required to divide 2646 by 7, or into 7 equal Parts, the Quotient will be found to be 378, as by the following Operation appeareth.

```
7) 2646 (378
   ...
   21
   --
    54
    49
    --
     56
     56
     --
     00
```

So if it be required to divide 946 by 8, the Quotient will be found to be 118, and 2 remaining after the Diviſion is ended. The Work followeth:

```
8) 946
```

```
8) 946 (118
   ...
   8
   ---
   14
    8
   ---
    66
    64
   ---
     2
```

Many Times the Dividend cannot exactly be divided by the Diviſor, but ſomething will remain, as in the laſt Example, where 946 was given to be divided by 8, the Quotient was 118, and there remained 2 after the Diviſion was ended: Now what is to be done in this Caſe with the Remainder, the Learner ſhall be taught when we come to treat of the Reducing, or Reduction of Fractions.

And here note, That if, after your Diviſion is ended, any Thing do remain, it muſt be leſſer than your Diviſor; for otherwiſe your Work is not rightly performed.

Other Examples are ſuch as follow:

```
8) 73464 (9183               9) 13758 (1528
   ....                         ....
   72                           9
   ---                          ---
   14                           47
    8                           45
   ---                          ---
    66                           25
    64                           18
   ---                          ---
     24                           78
     24                           72
      0                           ---
   ---                             6
```

5. But, if the Diviſor conſiſteth of more Places than one, then chuſe ſo many Figures from the left Side of the Dividend for a Dividual as there are Figures in the Diviſor, and put a Point under the fartheſt Figure of that Dividual

to the right Hand, and ſeek how often the firſt Figure on the left Side of the Diviſor is contained in the firſt Figure on the left Side of the Dividual, and place the Anſwer in the Quotient, and thereby multiply your Diviſor, placing your Product under your Dividual, and ſubtract it therefrom, placing the Remainder below the Line; then put a Point under the next Figure in the Dividend, and draw it down to the ſaid Remainder, and annex it on the right Side thereof, which makes a new Dividual, and proceed as before, till the Work is finiſhed.

And if it ſo happen, that after you have choſen your firſt Dividual (as it is before directed) you find it to be leſſer than the Diviſor, then put a Point under the Figure nearer to the right Hand, and ſeek how often the firſt Figure on the left Side of the Diviſor is contained in the two firſt Figures on the left of the Dividual, and place the Anſwer in the Quotient, by which multiply the Diviſor, and place the Product thereof in Order under the Dividual, and ſubtract it therefrom, and then proceed as before,

Always remembring that in all Caſes of *Diviſion*, if, after you have multiplied your Diviſor by the Figure firſt placed in the Quotient, the Product be greater than the Dividual, then you muſt cancel that Figure in the Quotient, and inſtead thereof put a Figure leſſer by an Unit (or One); and, if the Product be ſtill greater than the Dividual, make the Figure in the Quotient yet leſſer by an Unit, and thus do until your Product be leſſer than the Dividual, or at the moſt equal thereto, and then make Subtraction, *&c.*

So, if you would divide 9464 by 24, the Quotient will be found to be 394; I firſt put down the given Number, as is before directed in the 3d Rule. Now, becauſe my Diviſor conſiſteth of two Figures, I therefore put a Point under the ſecond Figure from the left Hand of my Dividend, which there is 4; wherefore I ſeek how often 2 (the firſt Figure on the left Side of the Diviſor) is contained in 9 (the like firſt in the Dividual); the Anſwer is 4, which I put in the Quotient, and thereby multiply all the Diviſor, and find the Product to be 96, which is greater

24) 9464 (39
  · · ·
  72
————
  226
  216
————
  10

than the Dividual 94; wherefore I cancel the 4 in the Quotient, and inſtead therefore I put three (an Unit leſſer) and by it multiply the Diviſor 24, and the Product is 72, which I ſubtract from 94 the Dividual, and the Remainder is 22; then do I make a Point under the next Figure 6 in the Dividend, and draw it down, and place it on the right Side of the Remainder 22, and it makes 226 for a new Dividual; now, becauſe the Dividual 226 conſiſteth of a Figure more than the Diviſor, therefore I ſeek how often 2 (the 1ſt Figure of the Diviſor) is contained in 22, the two firſt of the Dividual, and I ſay 9 times, wherefore I put 9 in the Quotient, and thereby multiply the Diviſor 24; the Product (216) I place it under the Dividual 226, and ſubtract it from it, and there remain 10.

```
24) 9464 (30
     . : .
     72
   -------
     226
     216
   -------
      10
```

Then I go on and make a Point under the next and laſt Figure (3) in the Dividend, and draw it down to the Remainder 10, and it makes 104 for a new Dividual; it is alſo a Figure more than the Diviſor, and therefore I ſee how often 2 is contained in 10? I anſwer 5 times; but multiplying my Diviſor by 5, the Product is 120, which is greater than the Dividual, and therefore I make it but 4, and by it multiply the Diviſor, and the Product is 96, which being placed under, and ſubtracted from the Dividual, there remain 8; and thus the whole Work of this Diviſion is ended, and I find that 9464, being divided by 24, or into 24 equal Parts, is found to be 394, as was before; and the Remainder is 8, as you ſee in the Work following:

```
24) 6464 (394
    . . . .
     72
   -------
     226
     216
   -------
     104
      96
   -------
     (8)
```

Another Example may be this: Let there be required the Quotient of 1183653 divided by 385: Firſt, I diſpoſe of the Numbers in order to their Dividing, and becauſe 118, the three firſt Figures of the Dividend, are leſſer than the Diviſor 385, I therefore make a Point under the fourth Figure which is 3, and ſee how often 3, the firſt Figurre of the Diviſor, is contained in 11: The Anſwer is 3, which I put in the Quotient, and therefore multiply the Diviſor 385, and the Product is 1155, which I ſubract from the Dividual 1183, and there remains 28. Then as before I draw down the next Figure, which is 6, and place it before the Remainder 28; ſo have I 268 for a new Dividual, and, becauſe it hath no more Figures than the Diviſor, I ſeek how often 3, the firſt Figure of the Diviſor, is contained in 2, the firſt Figures of the Dividual, and the Anſwer is 0; for a greater Number cannot be contained in a leſſer; wherefore I put 0 in the Quotient, and thereby, according to the 5th Rule, I ſhould multiply the Diviſor; but, if I do, the Product will be 0, and, 0 ſubtract from the Dividual 286, the Remainder is the ſame; wherefore I draw down the next Figure 5 from the Dividend, and put it before the ſaid Remainder 286, ſo I have 2865 for a new Dividual; and becauſe it conſiſteth of 4 Places, *viz.* a Place more than the Diviſor, I ſeek how often 3, the firſt Figure of the Diviſor, is contained in 28 the two firſt of the Dividual, and I ſay there is 9 times 3 is 27: but multiplying my whole Diviſor 385 thereby, I find the Product to be 3465 which is greater than the Dividual 2165, wherefore I chuſe 8, which is leſſer by an Unit then 9, and thereby I multiply my Diviſor 385, and the Product is 3080, which is ſtill greater than the ſaid Dividual;

```
385) 1183653 (3
        .
     1155
     ----
       28
```

```
385) 1183653 (30
        ..
     1155
     ----
      286
```

```
385) 1183653 (307
        ...
     1155
     ----
     2865
     2695
     ----
      170
```

; wherefore I chuſe another Number yet an Unit leſſer,
iz. and, having multiplied my Diviſor thereby, the
oduct is 2695, which is leſſer than the Dividual 2865,
herefore I put 7 in the Quotient, and ſubtract 2695 from
e Dividual 2865, and there remain 170; then I draw
wn the laſt Figure 3 in the Dividend, and place it be-
re the ſaid Remainder 170, and it makes 1703 for a
w Dividual; then, for the Rea-
n aforeſaid, I ſeek how often 3
contained in 17, the Anſwer is
; but, multiplying the Diviſor
ereby, the Product is 1925,
eater than the Dividual; where-
re I ſay it will bear 4, an Unit
ſſer, and by it I multiply the
iviſor 385, and the Product is
549, which is leſſer than the
ividual, and therefore I put 4
the Quotient, and ſubtract the
id Product from the Dividual,
d there remain 163; and thus the Work is finiſhed; and
find that, 1183653 being divided by 385, or into 385
ual Shares or Parts, the Quotient, or one of thoſe Parts, is
74, and beſides there are 163 remaining.

```
385) 1183653 (3074
        ....
     1155
     ----
      2865
      2695
      ----
       1703
       1540
       ----
        163
```

And, thus the Learner being well verſed in the Method
the foregoing Example, he may be ſufficiently quali-
ed for the Dividend of any greater Sum or Number into
many Parts as he pleaſeth; that is, he may underſtand
e Method of dividing by a Diviſor, which conſiſteth of
5, or 6, or any greater Number of Places, the Me-
od being the ſame with the foregoing Example in every
eſpect.

Other

Another Example may be this: Let there be required the Quotient of 1183653 divided by 385: Firſt, I diſpoſe of the Numbers in order to their Dividing, and becauſe 118, the three firſt Figures of the Dividend, are leſſer than the Diviſor 385, I therefore make a Point under the fourth Figure which is 3, and ſee how often 3, the firſt Figurre of the Diviſor, is contained in 11: The Anſwer is 3, which I put in the Quotient, and therefore multiply the Diviſor 385, and the Product is 1155, which I ſubract from the Dividual 1183, and there remains 28. Then as before I draw down the next Figure, which is 6, and place it before the Remainder 28; ſo have I 268 for a new Dividual, and, becauſe it hath no more Figures than the Diviſor, I ſeek how often 3, the firſt Figure of the Diviſor, is contained in 2, the firſt Figures of the Dividual, and the Anſwer is 0; for a greater Number cannot be contained in a leſſer; wherefore I put 0 in the Quotient, and thereby, according to the 5th Rule, I ſhould multiply the Diviſor; but, if I do, the Product will be 0, and, 0 ſubtract from the Dividual 286, the Remainder is the ſame; wherefore I draw down the next Figure 5 from the Dividend, and put it before the ſaid Remainder 286, ſo I have 2865 for a new Dividual; and becauſe it conſiſteth of 4 Places, *viz.* a Place more than the Diviſor, I ſeek how often 3, the firſt Figure of the Diviſor, is contained in 28 the two firſt of the Dividual, and I ſay there is 9 times 3 is 27: but multiplying my whole Diviſor 385 thereby, I find the Product to be 3465 which is greater than the Dividual 2165, wherefore I chuſe 8, which is leſſer by an Unit then 9, and thereby I multiply my Diviſor 385, and the Product is 3080, which is ſtill greater than the ſaid Dividual;

```
385) 1183653 (3
         .
     1155
     ----
       28
```

```
385) 1183653 (30
         ..
     1155
     ----
      286
```

```
385) 1183653 (307
         ...
     1155
     ----
      2865
      2695
      ----
       170
```

; wherefore I chuſe another Number yet an Unit leſſer,
iz. and, having multiplied my Diviſor thereby, the
roduct is 2695, which is leſſer than the Dividual 2865,
herefore I put 7 in the Quotient, and ſubtract 2695 from
e Dividual 2865, and there remain 170; then I draw
own the laſt Figure 3 in the Dividend, and place it be-
re the ſaid Remainder 170, and it makes 1703 for a
ew Dividual; then, for the Rea-
n aforeſaid, I ſeek how often 3
contained in 17, the Anſwer is
; but, multiplying the Diviſor
ereby, the Product is 1925,
eater than the Dividual; where-
re I ſay it will bear 4, an Unit
ſſer, and by it I multiply the
iviſor 385, and the Product is
549, which is leſſer than the
ividual, and therefore I put 4
the Quotient, and ſubtract the
id Product from the Dividual,
d there remain 163; and thus the Work is finiſhed; and
find that, 1183653 being divided by 385, or into 385
ual Shares or Parts, the Quotient, or one of thoſe Parts, is
74, and beſides there are 163 remaining.

```
385) 1183653 (3074
     ....
     1155
     ----
     2865
     2695
     ----
      1703
      1540
      ----
       163
```

And, thus the Learner being well verſed in the Method
the foregoing Example, he may be ſufficiently quali-
ed for the Dividend of any greater Sum or Number into
many Parts as he pleaſeth; that is, he may underſtand
e Method of dividing by a Diviſor, which conſiſteth of
5, or 6, or any greater Number of Places, the Me-
od being the ſame with the foregoing Example in every
eſpect.

Other

Other Examples in Diviſion.

27986) 835584790 (29850
· · · · ·
55972

251874
275964

240907
223888

170199
167916

Remain 22830

196374) 473986018 (2413
· · · ·
392748

812380
785496

268841
196374

724678
589122

Remain 135556

So if you divide 47386473 by 68736, you will find th Quotient to be 896, and 45257 will remain, after the Wor is ended.

In like Manner, if you would divide 384672204 b 413064, the Quotient will be 7963, and the Remainder after the Diviſion will be 100572.

Compendium in Diviſion.

1. IF any given Number be to be divided by anothe Number that hath Cyphers annexed on the rig Side thereof, omitting the Cyphers, you may cut off

man

many Figures from the right Hand of the Dividend, as there are Cyphers before the Diviſor, and let the remaining Numbers in the Dividend be divided by the remaining Number or Numbers of the Diviſor, obſerving this Caution: That if, after your Diviſion is ended, any Thing remain, you are to annex thereto the Number or Numbers that were cut off from the Dividend; and ſuch now found Number ſhall be the Remainder. (See Mr. *Oughtred*'s *Clavis Mathematica*, cap. v. 3.) As for Example, Let it be required to divide 46658 by 400: Now, becauſe there are two Cyphers before the Diviſor, I cut off as many Figures from before the Dividend, *viz.* 58, ſo that then there will remain only 466 to be divided by 4, and the Quotient will be 116, and there will remain 2, to which I annex the two Figures 58, which were cut off from the Dividend, and it makes 258 for the true Remainder; ſo that I conclude, 46658 being divided by 400, the Quotient will be 116, and 258 remain after the Work is ended; as by the Work in the Margin.

```
4|00) 466|58 (116
       ..
      4
     ---
      06
       4
     ---
       26
       24
       ---
       258
```

2. And hence it followeth, that, if the Diviſor be 1, or an Unit with Cyphers annexed, you may cut off ſo many Figures from before the Dividend, as there are Cyphers in the Diviſor, and then the Figure or Figures that are on the left Hand will be the Quotient, and thoſe that are on the right Hand will be the Remainder after this Diviſion is ended. *Vid. Gem. Priſ. Arith. Par.* I As thus; if 45783 were to be divided by 10, I cut off the laſt Figure, 3, with a Daſh thus, 4578|3, and the Work is done, and the Quotient is 4578, the Number on the left Hand of the Daſh, and the Remainder 3, on the right Hand. In like Manner, if the ſame Number 45783 were to be divided by 100, I cut off two Figures from the End thus, 457|83, and the Quotient is 457, and the Remainder is 83. And, if I am to divide the ſame Number by 1000, I cut off three from the End thus, 45|783, and the Quotient is 45, and 783 is the Remainder, &c.

6. The general Effect of *Diviſion* is contained in the Definition of the ſame, that is, by having two unequal Numbers, to find a third Number in ſuch Proportion to the Dividend, as the Diviſor hath to an Unit or 1: It alſo diſcovers what Reaſon or Proportion there is between Numbers; ſo, if you divide 2 by 4, it quotes 3, which ſhews the Reaſon or Proportion of 4 to 12 is triple.

The ſecond Effect is, by the ſuperficial Meaſure or Content, and the Length of any Oblong, Rectangular Parallelogram, or ſquare Plane known, to find out the Breadth thereby; or contrariwiſe, by having the Superficies, and alſo by having the Solidity and Length of a Solid, to find the Superficies of the Baſe, *&c. & contra.*

The third Effect, is, by the Contents, Reaſon, Price, Value, Buying, Selling, Expences, Wages, Exchange, Intereſt, Profit, or Loſs of any Number of Things (be it Money, Merchandize, or what elſe) to find out the Content, Reaſon, Price, Value, Buying, Selling, Expences, Wages, Exchange, Intereſt, Profit, or Loſs of any one Thing of the like Kind.

The fourth Effect is, to aid, to compoſe, and to make other Rules, but principally the Rule of *Proportion*, called the *Golden Rule*, or *Rule of Three*, and the Reduction of Monies, Weights, and Meaſures of one Denomination into another; by it alſo Fractions are abbreviated, by finding a common Meaſure to the Numerator and Denominator, thereby diſcovering commenſurable Numbers.

If you divide the Value of any certain Quantity by the ſame Quantity, the Quotient diſcovers the Rate or Value of the Integer: As if 8 Yards of Cloth coſt 96*s.* what will 1 Yard coſt? You divide 96 by 8, and the Quotient is 12*s.* which is the Price of 1 Yard,

If you divide the Value or Price of any unknown Quantity, by the Value of the Integer, it gives you in the Quotient that unknown Quantity, whoſe Price is thus divided; as, if 12 Shillings were the Value of a Yard, I would know how many Yards are worth 96 Shillings? Here if you divide (96) the Price or Value of the unknown Quantity, by 12, the Rate of the Integer, or 1 Yard, the Quotient will be 8, which is the Number of Yards worth 96*s.*

Some Queſtions anſwered by Diviſion may be theſe following

Queſt. 1. If 22 Things coſt 66 Shillings, what will 1 ſuch Thing coſt? *Facit* 3 Shillings, for, if you divide 66 by 22, the Quotient is 3 for the Anſwer; ſo if 36 Yards or Ells of any Thing to bought or ſold for 108 *l.*; how much will one Yard or Ell be bought or ſold for? *Facit* 3 *l.* for if you divide 108 by 36 Yards, the Quotient will be 3 *l.* the Price of the Integer.

Queſt. 2. If the Expence, Charges, or Wages of 7 Years amount to 868 *l.* what is the Expence, Charges, or Wages of one Year? *Facit* 124 *l.* for if you divide 868 (the Wages of 7 Years) by 7 (the Number of Years) the Quotient will be 124 *l.* for the Anſwer. See the Work:

```
7) 868 (124
   ...
   7
   ——
   16
   14
   ——
    28
    28
   ——
   (0)
```

Queſt. 3. If the Content of a ſuperficial Foot be 144 Inches, and the Breadth of a Board be 9 Inches, how many Inches of that Board in Length will make ſuch a Foot? *Facit* 16 Inches; for by dividing 144 (the Number of ſquare Inches in a ſquare Foot) by 9 (the Inches in the Breadth of a Board) the Quotient is 16 for the Number of Inches in Length of that Board to make a ſuperficial Foot.

```
9) 144 (16 Inches.
    .
   9
   ——
   54
   54
   ——
   (0)
```

Queſt. 4. If the Content of an Acre of Ground be 160 ſquare Perches, and the Length of a Furlong propounded be 80 Perches, how many Perches will there go in Breadth to an Acre? *Facit* 2 Perches; for, if you divide 160, the Number of Perches in an Acre, by 80, the Length of the Furlong in Perches, the Quotient is 2 Perches; and ſo many in Breadth of that Furlong will make an Acre.

80) 160 (2 Perches.
160
0

Queſt. 5. If there be 893 Men to be made up into a Battle, the Front conſiſting of 47 Men; what Number muſt there be in the File? *Facit* 19 deep in the File; for, if you divide 893, the Number of Men, by 47, the Number in the Front, the Quotient will be 19 in Depth of the File. The Work followeth:

47) 893 (19 *deep in File.*
47
423
423
0

Queſt. 6. There is a Table, whoſe ſuperficial Content is 72 Feet, and the Breadth of it at the End is 3 Feet; now I demand what is the Length of this Table? *Facit* 24 Feet long; for, if you divide 72, the Content of the Table in Feet, by 3, the Breadth of it, the Quotient is 24 Feet for the Length thereof, which was required. See the Operation.

3) 72 (2
6
12
12
0

The Proof of Multiplication and Diviſion.

Multiplication and Diviſion interchangeably prove ea other; for, if you would prove a Sum in Diviſion, wh ther the Operation be right or no, multiply the Quotie by the Diviſor; and, if any thing remain after the Diviſor is ended, add to it the Product, which Product, if your Sum was rightly divided, will be equal to the Dividend. And contrariwiſe, if you would prove a Sum in Multiplication, divide the Product by the Multiplier, and, if the Work was rightly performed, the Quotient will be equal tothe Multiplicand. See the Example, where the Work is done and undone. Let 7654 be given to be multiplied by 3242, the Product will be 24814268, as by the Work appeareth.

```
    7654
    3242
--------
   15308
  30616
 15308
22962
--------
24814268
```

And then, if you divide the ſaid Product 24814268 by 3242, the Multiplier, the Quotient will be 7654, equal to the given Multiplicand.

```
3242) 24814268 (7654
      ....
      22694
      -----
       21202
       19452
       -----
        17506
        16210
        -----
         12968
         12968
         -----
             0
```

In like manner, to prove a Sum or Number in Diviſion, f 24814268 were divided by 3242, the Quotient will be ound to be 7654; then, for Proof, if you multiply 7654, he Quotient, by 3242, the Diviſor, the Product will amount o 24814268, equal to the Dividend.

Or, you may prove the laſt, or any other Example in ultiplication, thus, *viz.* divide the Product by the Multilicand, and the Quotient will be equal to the Multiplier. ee the Work.

```
          7654
          3242
         -----
         15308
        30616
       15308
      22962
   --------------------
7654) 24814268 (3242
          ...
      22962
      -----
       18522
       15308
       -----
        32146
        30616
        -----
         15308
         15308
         -----
          (0)
```

From whence there ariſes this Corollary, that any Operation in *Diviſion* may be proved by *Diviſion*; for, if, after your *Diviſion* is ended, you divide the Dividend by the new Quotient, the new Quotient thence ariſing will be equal to the Diviſor of the firſt Operation; for Trial whereof, let the laſt Example be again repeated,

```
3242) 24814268 (7654
           ...
      22694
      -----
       21202
       19452
       -----
        17506
        16210
        -----
         12968
         12968
         -----
          (0)
```

For Proof whereof divide again 24814268 by the Quotient 7654, and the Quotient hence will be equal to the Diviſor 3242. See the Work,

```
7657) 24814268 (3242
          ...
      22962
      -----
       18522
       15308
       -----
        32146
        30616
        -----
         15308
         15308
         -----
          (0)
```

But, in proving Diviſion by Diviſion, the Learner is to obſerve this following Caution: That, if, after his Diviſion is ended, there be any Remainder, before you go about to prove your Work, ſubtract the Remainder out of your Dividend, and then work, as in the following Example, where it is required to divide 43876 by 765; the Quotient here is 57, and the Remainder is 271. See the Work following:

```
765) 43876 (57
        .
     3825
     ----
      5626
      5355
      ----
       271
```

Now, to prove this Work, ſubtract the Remainder 271 out of the Divideud 43876, and there remain 43605, for a new Divident to be divided by the former Quotient 57, and the Quotient thence ariſing is 765, equal to the given Diviſor, which proveth the Operation to be right.

```
    43876
      271
    -----
57) 43605 (765
    ....
    399
    -----
     370
     342
    -----
      285
      285
    -----
        0
```

Thus have we gone through the four Species of *Arithmetick*, viz. *Addition*, *Subtraction*, *Multiplication*, and *Diviſion*, upon which the following Rules, and all other Operations whatſoever, that are poſſible to be wrought by Numbers, have their immediate Dependence, and by them are reſolved. (Vide *Gem. Friſ.* Arith. Part I.) Therefore, before the Learner makes a farther Step in this Art, let him be well acquainted with what has been delivered in the foregoing Chapters.

CHAP. VIII.

Of Reduction.

1. *Reduction* is that which brings together two or more Numbers, of different Denominations, into one Denomination, *Hall*'s *Arith.* Chap. xiii. Page 152. or it ſerveth to change or alter Number, Money, Weight, Meaſure, or Time, from one Denomination to another; and likewiſe to abridge Fractions to the loweſt Term. All which it doth preciſely, that the firſt Proportion remaineth without the leaſt Jot of Error or Wrong committed; ſo that it belongeth as well to the Fractions as Integers, of which in the proper Place. *Reduction* is generally performed by *Multiplication* or *Diviſion*; from whence we may gather, that,

2. *Reduction* is either aſcending or deſcending.

3. *Reduction* deſcending is, when it requireth to reduce a Sum or Number of a greater Denomination into a leſſer; which Number, when it is ſo reduced, ſhall be equal in Value to the Number firſt given in the greater Denomination; *Wing*'s *Arith.* 7, 2, 3, 4. as if it were required to know how many Shillings, Pence, or Farthings, are equal in Value to 100*l.* or how many Ounces are contained in 4500 *lb.* Weight; or how many Days, Hours, or Minutes, there are in 240 Years, *&c.* And this Kind of Reduction is generally performed by Multiplication.

4. *Reduction* aſcending is, when it is required to reduce or bring a Sum or Number of a ſmaller Denomination into a greater, which will be equivalent to the given Number; as ſuppoſe it were required to find out how many Pounds, Shillings, or Pence are equal in Value to 43785 Farthings; or how many Hundreds are equal to (or in) 3748 Pounds, *&c.* and this Kind of Reduction is always performed by Diviſion.

5. When any Sum or Number is given to be reduced into another Denomination, you are to conſider whether it ought to be reſolved by the Rule deſcending or aſcending, *&c.* by Multiplication or Diviſion; if it be to be performed by Multiplication, conſider how many Parts of the Denomination, into which you would reduce it, are contained in an Unit or Integer of the given Number, and multiply the ſaid given Number thereby, and the Product thereof will be the Anſwer to the Queſtion. As if the Queſtion were, In 38 Pounds how many Shillings? Here I conſider, that in 1 Pound are 20 Shillings, and that the Number of Shillings in 38 Pounds will be 20 times 38; wherefore I multiply 38 *l.* by 20, and the Product is 760, and ſo many Shillings are contained in 38 Pounds, as in the Margin.

38
20
—
760

But, when there is a Denomination or Denominations between the Number given and the Number required, you may, if you pleaſe, reduce it into the next inferior Denomination, and then into the next lower than that, *&c.* until you have brought it into the Denomination required. As for Example, Let it be demanded in 132 Pounds how many Farthings? Firſt, I multiply 132 (the Number of Pounds given) by 20, to bring it into Shillings, and it makes 2640 Shillings; then do I multiply the Shillings 2640 by 12, to bring them into Pence, and it produceth 31680, and ſo many Pence are contained in 2640, Shillings, or 132 Pounds; then do I multiply the Pence, *viz.* 31680 by 4 to bring them into Farthings, becauſe 4 Farthings are a Penny, and I find the Product thereof to be 126720, and ſo many Farthings are equal in Value to 123 Pounds. As by the Work in the Margin.

$$\begin{array}{rl} 132 & \textit{Pounds} \\ 20 & \\ \hline 2640 & \textit{Shil.} \\ 12 & \\ \hline 5280 & \\ 2640 & \\ \hline 31680 & \\ 4 & \\ \hline 126720 & \textit{Far.} \end{array}$$

6. And, if the Number propounded to be reduced is to be divided or wrought by the Rule aſcending, conſider how many of the given Numbers are equal to an Unit, or Integer, in that Denomination to which you would reduce your given Number, and make that your Diviſor, and the given Number your Dividend; and the Quotient thence ariſing will be the Number ſought or required: As for Example, Let it be required to reduce 2640 Shillings into Pounds? Here I conſider that 20 Shillings are equal to a Pound; wherefore I divide 2640, the given Number, by 20, and the Quotient is 132, and ſo many Pounds are contained in 2640 Shillings. In Reduction deſcending and aſcending, the Learner is adviſed to take particular Notice of the Tables delivered in the ſecond Chapter of this Book, where he may be informed what Multipliers and Diviſors to make Uſe of in the reducing of any Number to any other Denomination whatſoever, eſpecially *Engliſh* Money, Weights, Meaſures, Time and Motion; but in this Place it is not convenient to meddle with Foreign Coins, Weights, or Meaſures.

$$\begin{array}{r} \qquad\qquad \textit{l.} \\ 2|0)\ 264|0\ (132 \\ ..\quad \\ 2\quad\ \ \\ \hline 6\quad \\ 6\quad \\ \hline 4 \\ 4 \\ \hline 0 \end{array}$$

But if, in Reduction aſcending, it happen that there is a Denomination or Denominations between the Number given and the Number required, then you may reduce your

Number given into the next ſuperior Denomination, and, when it is ſo reduced, bring it into the next above that, and ſo on until you have brought it into the Denomination required. As for Example, Let it be demanded in 126720 Farthings how many Pounds? Firſt, I divide my given Number, being Farthings, by 4, to bring them into Pence, becauſe 4 Farthings make one Penny, and there are 31680 Pence; then I divide 31680 Pence by 12, and the Quotient giveth 2640 Shillings, and then I divide 2640 Shillings by 20, and the Quotient giveth 132 Pounds, which are equal in Value to 126720 Farthings: See the whole Work as it followeth:

```
          12)      2|0)    l.
   4) 126720 (31680 (264|0 (132
      ....     ...    ..

      12       24      2
      --       --     --
       6       76      6
       4       72      6
      --       --     --
       27      48      4
       24      48      4
      --       --     --
        32      0      0
      --
        0
```

7. When the Number given to be reduced conſiſts of diverſe Denominations, as Pounds, Shillings, Pence, and Farthings, or of Hundreds, Quarters, Pounds, and Ounces, &c. then you are to reduce the higheſt or greateſt Denomination into the next Inferior, and add thereunto the Number ſtanding in the Denomination, which your greateſt or higheſt Number is reduced to; then reduce the Sum into the next inferior Denomination; adding thereto the Number ſtanding in that Denomination; do

```
        l.     s.    d.
        48     13    10
        20
     ------------------
       960 Shil.
Add     13
     ------------------
Sum    973
        12
     ------------------
      1946
      973
     ------------------
     11676 Pence
Add     10
     ------------------
Sum  11686
```

do ſo until you have brought the Number given into the Denomination propoſed. As if it were required to reduce 48 *l.* 13 *s.* 10 *d.* into Pence; firſt, I bring 48 *l.* into Shillings, by multiplying it by 20, and the Product is 960 Shillings; to which I add the 13 Shillings, and they make 973; then I multiply 973 by 12, to bring the Shillings into Pence, and they make 11676, to which I add the 10 *d.* and they make 11686 Pence for the Anſwer.

8. If in Reduction aſcending, after Diviſion is ended, any Thing remain, ſuch Remainder is of the ſame Denomination with the Dividend.

Example, In 4783 Farthings, I demand how many Pounds?

Firſt, I divide the given Number of Farthings, *viz.* 4783 by 4, to bring them into Pence, and the Quotient is 1195, and there remain 3, after the Work of Diviſion is ended, which are 3 Farthings.

Again, I divide 1195 Pence, the ſaid Quotient, by 12, to reduce them into Shillings, and the Quotient is 99 Shillings, and there is a Remainder of 7, which is 7 Pence,

And then I divide 99 Shillings, the laſt Quotient, by 20, to bring it into Pounds, and the Quotient is 4 *l.* and there remain 19 Shillings; ſo that I conclude that in 4783, the propoſed Number of Farthings, there are 4 Pounds, 19 Shillings, 7 Pence, 3 Farthings: View the following Operation:

```
           12     2|0
4) 4783 (1195 (9|9   4 Pounds.
   ....    .
    4      108  8
   ---     ---  ---
    7      115  19 Shil.
    4      108
   ---     ---
   38 rem.  7 Pence.
   36
   ---
   23
   20
   ---
    3 Farth. Rem.
```

	l.	*s.*	*d.*	*qrs.*
Facit	4	19	7	3

More Examples in Reduction of Coin.

Queſt. 1. In 438 *l.* how many Shillings? *Facit* 8760 Shillings; for, by multiplying the 438 by 20, the Product amounteth to ſo much. See the Work in the Margin.

438 *l.*
20
Facit 8760 *l.*

Queſt. 2. In 467 *l.* how many Pence? Firſt, multiply the given Number of Pounds 467 by 20, to bring it into Shillings, and it makes 9340 Shillings; then multiply the Shillings by 12, and it produceth 112080 Pence, as in the Margin.

467 *Pounds.*
20
9340 *Shil.*
12
18680
9340
Facit 112080

Or it may be reſolv'd thus, *viz.* multiply the given Number of Pounds 467, by 240, the Number of Pence in a Pound, and the Product is the ſame, *viz.* 112080 *d.* as by the Operation appeareth.

467 *Pound.*
240
18680
934
Facit 112080 *Pence.*

5673 *Pounds.*
20
113460
12
226920
113460
1361520 *Pence.*
4
Facit 5446080

Or this Queſtion might have been thus reſolved, *viz.* multiply 5673, the given Number of the Pounds, by 960, the Number of Farthings in a Pound, and it produceth the ſame Effect, as you may ſee by the Work.

5673 *Pounds*	20 *Shillings*
960	12
340380	240 *Pence*
51057	4
Facit 5446080 *Farthings.*	960 *Farthings.*

Otherwiſe thus: Firſt bring the given Number 5673 *l.* into Shillings, and multiply the Shillings by 48, the Number of Farthings in a Shilling, and the ſame Effect is thereby likewiſe produced, *viz.*

5673 *Pounds*	12 *Pence.*
20	4
113460 *Shillings*	48
48	
907680	
453840	
Facit 5446080 *Farthings.*	

Theſe various Ways of Operation are expreſſed to inform the Judgment of the Learner, with the Reaſon of the Rule. More Ways may be ſhewn, but theſe are ſufficient even for the meaneſt Capacities.

Queſt. 4. In 458 *l.* 16 *s.* 7 *d.* 3 *qrs.* how many Farthings? To reſolve this Queſtion, conſider the 7th Rule of this Chapter, and work as you are there directed, and you will find the aforeſaid given Number to amount to 440479 Farthings, *viz.*

l. 458

l.	*s.*	*d.*	*qrs.*
458	16	7	3

20

9160 *Shillings.*
Add 16

Sum 9176 *Shillings.*
12

18352
9176

110112 *Pence.*
Add 7

Sum 110119 *Pence.*
4

440476 *Farthings.*
Add 3

Sum 440479 *Farthings.*

This laſt Queſtion, or any other of this Kind, may be more conciſely reſolved thus, *viz.* When you multiply the Pounds by 20, to bring them into Shillings, to the Product of the firſt Figures, add the Figure ſtanding in the Place of Units in the Denomination of Shillings; but becauſe the firſt Figure in the Multiplier is (0) I ſay, 0 times 8 is nothing, but 6 is 6, which I put down for the firſt Figure in the Product; then, becauſe the Multiplier is 0, I go on no farther with it; for, if I ſhould, the whole Product would be 0; but proceed, and, when I come to multiply the ſecond Figure in the Multiplier, to the Product of it, I add the Figure ſtanding in the Place of Tens in the Denomination of Shillings, which is 1, ſaying, 2 times 8 is 16, and the ſaid Figure 1 is 17; then I ſet down 7; and carry the Unit to the Product of the next Figure, as is directed in the 5th Rule of the 6th Chapter foregoing, and finiſh the Work. So that now you may have the whole

Product and Sum of Shillings at one Operation, which is the ſame as before; and when you multiply the Shillings by 12, to bring them into Pence, after the ſame Manner, add to the Product the Number ſtanding in the Denomination of Pence; and ſo when you multiply the Pence by 4, to bring them into Farthings, add to the Product the Number ſtanding under the Denomination of Farthings. See the laſt Queſtion thus wrought:

l.	*s.*	*d.*	*qrs.*
458	16	7	3
20			
9176 *Shil.*			
12			
18359			
9176			
110119			
4			

Facit 440479 *Farthings.*

After the Method laſt preſcribed, are all the following Examples, that are of the ſame Nature, wrought and reſolved.

Queſt. 5. In 4375866 Farthings, I demand how many Pounds, Shillings, Pence, and Farthings?

To reſolve this Queſtion, Firſt, I divide the given Number of Farthings by 4, and the Quotient is 1093966 Pence, and there remain 2, after the Diviſion is ended, which by the 8th Rule foregoing, is 2 Farthings; then I divide 1093966 Pence by 12, and the Quotient is 91163 Shillings, and there remain 10 after Diviſion, which by the ſaid 8th Rule are ſo many Pence, *viz.* 10 *d.* then I divide 91163 Shillings by 20, and the Quotient 4558 *l.* and there remain 3 Shillings; ſo the Work is finiſhed, and I find that in 4375866 Farthings there are 4558 *l.* 3 *s.* 10 *d.* 2 *qrs.*

(12

```
                 (12        2|0       l.
    4) 4375866 (1093965 (9116|3 (4558
       .......    .....   ....

     4          108       8
    ---         ---      ---
     37          13       11
     36          12       10
     --          --       --
      15          19       11
      12          12       10
      --          --       --
       38          76       16
       36          72       16
       --          --       --
        26          46       3 Shil.
        24          36
        --          --
         26         10 d.
         24
         --
          2 qrs.            l.   s.  d.  qrs.
                   Facit 4558   3   10   2
```

Queſt. 6. In 4386 *l.* I demand how many Groats?

To reſolve this Queſtion, I reduce the given Number of Pounds into Shillings, and there are 87720 Shillings; now I conſider that in a Shilling are 3 Groats, therefore I multiply the Shillings by 3, and it produceth 263160 Groats, See the Work:

```
        4386 Pounds
          20
        ----
       87720 Shil.
           3
       -----
Fac.  263160 Groats.
```

The Queſtion might have been otherwiſe reſolved thus, *viz.* conſider in a Pound, or 20 Shillings, there are three times 20 Groats, which make 60, by which I multiply the Number of Pounds given, and it produceth the ſame Effect at one Operation, as followeth.

4386

4386 *Pounds.*
60 *Groats* in 20 *s.*

Facit 263160 *Groats* in 4386 *l.*

Queſt. 7. In 43758 Three pences, I deſire to know how many Pounds?

To reſolve this, and many ſuch like Queſtions: Firſt, I divide my given Number of Three-pences by 4, becauſe 4 Three-pences are in a Shilling, and the Quotient is 10939 Shillings; and there remain 2, after the Diviſion is ended, which are 2 Three-pences (by the 8th Rule of this Chapter) which are equal in Value to 6 *d.* Then I divide 10939 Shillings, and there remain 2, after the Diviſion of 10939 Shillings by 2, and the Quotient giveth 549 *l.* and 19 *s.* remain: So that I conclude ſn 43578 Pieces, of Three-pence *per* Piece, there are 456 *l.* 19 *s.* 9 *d.* as by the Work appeareth:

```
4) 43758   2|0      l.   s.  d.
   ····  1093|9  (546   19  06
              ··
   4
   ——       10
    37      ——
    36       9
   ——        8
     15     ——
     12      13
    ——       12
      38    ——
      36     19 Sh.
     ——
           (2) Three-pences or 6 d.
```

This Queſtion might have been ortherwiſe reſolved thus, *viz.* Firſt, multiply the given Number of Three pences, 43758, by 3, the Number of Pence in Three-pence, and the Product, *viz.* 134274, is the Number of Pence equal to the given Number of Three-pences which Number of Pence may be brought into Pounds by dividing by 12, and by 20, and the Quotient you will find to be equal to the former Work, 546 *l.* 19 *s.* 6 *d.*

43758

```
                          43758
                              3
——————————————————————————2|0    l.   s. d.
———————————12) 131274   (1093 (9  546  19 6
               ....        ..
               12          10
               ——          ——
               112          9
               108          8
               ——          ——
                 47        13
                 36        12
                ——         ——
                114 re.   (19 Sh.
                108
                ——
          (6) Pence remain.
```

Or thus: Divide the given Number of 3 Pences by the Number of Three-pences in a Pound, or 20 Shillings, which you will find to be 80; if you multiply 20*s.* by 4, the Nnmber of Three-pences in a Shilling, you will find the Quotient to be 546 *l.* as before, and a Remainder of 78 Three-pences; and, if yon divide thoſe 78 Three-pences by 4, becauſe there are 4 Three-pences in a Shilling, you will find the Quotient to be 19 *s.* and 2 Three-pences remain, which are equal to 6*d.* which is the ſame that was before found.

8|0) 4375|8 (546 19 6   20
                                          4
40   80
37
32
55
48
4) 78 (19 s.
4
38
36
2 Three-pences, or 6 *d.*

Queſt. 8. In 4785 *l.* 13 *s.* how many Pieces of 13 ½ *per* Piece?

This Queſtion cannot be reſolved by Reduction deſcending or aſcending abſolutely, becauſe 13 *d.* ½ is no even Part of a Pound, but rather by them both jointly, *viz.* by Multiplication and Diviſion; but if you bring the Number given into Half-pence, and divide the Half-pence by the Half-pence in 13 *d.* ½, *viz.* 27, the Quotient, will be the Anſwer; for, having brought 4785 *l.* 13 *s.* into Half-pence, I find it makes 2297112, which I divide by 27, becauſe there are ſo many Half-pence in 13 *d.* ½, and the Quotient gives 85078 Pieces of 13 *d.* ½, and 6 Half-pence remain over and above: Obſerve the Work following:

```
  l.     s.     d.
 4785   13    13½
   20         ———
 ————          2
 95713 Shillings 27 Half-pence
     24 Half-pence in a Shilling.
 ————
  382852
 191426
 ——————
 2297112 Half-pence in the given Number.
27) 2297112 (85078 Pieces of 13 d. ½.
    . . . . .
    216
    ———
     137
     135
     ———
      211
      189
      ———
       222
       216
       ———
```

Remain (6) Half-pence.

It would have produced the ſame Anſwer, if you had reduced your given Number into Farthings, and divided by the Farthings in 13*d.* ½. *viz.* 54; for always the Dividend and the Diviſor muſt be of one Denomination, and then you would have had a Remainder of 12 Farthings, which are equal in Value to the former Remainder of 6 Half-pence, as you may prove at your Leiſure.

Queſt. 9. In 540 Dollars at 4 *s.* 4 *d. per* Dollar, how many Pounds Sterling?

Firſt, bring your given Number of Dollars into Pence, and then your Pence into Pounds, according to the former Direction: Thus in 4 *s.* 4 *d. viz.* a Dollar, you will find 52 Pence; by which multiply 540 Dollars, and it produceth 28080 Pence, which if you divide by 240 (the Pence in one Pound) the Quotient will give you 117 *l.* which are equal in Value to 540 Dollars, at 4 *s.* 4 *d. per* Dollar.

```
                  s.   d.
        540       4    4
         52      12
       -----    ----
       1080      52
      2700
      ------
24|0) 2808|0 (117
        . .
       24
      ----
       40
       24
      ----
       168
       168
      ----
       (0)
```

The foregoing Queſtion might have been otherwiſe wrought thus, *viz.* Multiply 540, your given Number of Dollars, by 13, the Number of Groats in a Dollar, or 4 *s.* 4 *d.* and it produceth 7020 Groats; which divide by 60 the Groats in one Ponnd, or 20 Shillings, and the Quotient is 117, as before. See the Work:

```
                  s.   d.
      540         4    4
       13         3
     -----      -----
     1620        13
     540        -----
     -----
6|0) 702|0 (117
       . .
      6
     ----
      10
       6
     ----
      42
      42
     ----
      (0)
```

Queſt. 10. In 547386 Pieces of 4 *d.* ½ *per* Piece, I demand how many Pounds, Shillings, and Pence?

Firſt, bring your given Number, Four-pence Half-penny, all into Half-pence; which you will do, if you multiply by 9, the Number of Half-pence in 4 *d.* ½, and the Product is 4926474 Halfpence; which are brought into Pounds, it if you divide them by 24, the Half-pence in a Shiling, and 20, the Shillings in a Pound, and make 10263 *l.* 9*s.* 9 *d.*

```
                                                   d.
                                                   4 1/2
  547386                                           2
       9                                         ------
  ------ ------ ------2|0      l.             9 Half-pence
24) 4926474 (20526|9 (10263
    .....   .....
     48        2
    ----     ----
     126       05
     120        4
     ----     ----                    l.    s.   d.
       64       12              Fac. 10263   9    9
       48       12
      ----     ----
       167        6
       144        6
      ----     ----
        234 rem.   (9) Shillings.
        216
      ------
Rem.    18 Half pence or 9 d.
```

Queſt. 11. In 4386 *l.* I demand how many Pieces of 6*d.* of 4 *d.* and of 2 *d.* of each an equal Number? That is to ſay, What Number of Six-pences, Groats, and Two-pences will make 4386 *l.* and the Number of each equal?

The Way to reſolve Queſtions of this Nature is to add the ſeveral Pieces into which the given Number is to be brought, into one Sum, and reduce the given Number into the ſame Denomination with their Sum; then divide the ſaid Number ſo reduced by the ſaid Sum, and the Quotient will give you the exact Number of each Piece. And, after the ſame Method, will we proceed to reſolve the preſent Queſtion, *viz.*

```
4386 Pounds        6 d.
 240 Pence         4 d.
                   2 d.
 ------           ----
175440            12
8772
-------
12) 1052640 (87720
      .....
    96
    --
     92
     84
     --
      86
      84
      --
       24
       24
       --
       (0)
```

So that I conclude by the Operation, that 87720 Six-pences, 87720 Groats, and 87720 Two-pences, are juſt as much or equal to 4386 *l.* or, if you admit of 5 *s.* to be thus divided, it is equal to 5 Six-pences, and 5 Four-pences, or Groats, and 5 Two-pences.

Another Queſtion of the ſame Nature with the laſt is this following, *viz.*

Queſt. 12. A Merchant is deſirous to change 148 *l.* into Pieces of 13 *d.* ½, of 12 *d.* 9 *d.* 6 *d.* and 4 *d.* and he will have of each Sort an equal Number of Pieces: I deſire to know the Number.

Do as you were taught in the laſt Queſtion, *viz.* add the ſeveral Pieces together, and reduce the Half-pence; then reduce the Sum to be changed, *viz.* 148 *l.* into the ſame Denomination, and divide the Greater by the Leſſer, and in the Quotient you will find the Anſwer, *viz.* 798 is the Number of each of the Pieces required, and 18 remain, which are 18 Half-pence, by the 8th Rule of this Chapter. See the Work as followeth:

148	13½
240 Pence in a Pound	12
	9
5920	6
296	4
35520 Pence in 248 *l.*	Sum 44½
2	2
71040 Half-pence.	89 Half-pence.

89) 71040 (798 Pieces of each Sort.
623
874
801
730
712
Rem. (18) Half-pence.

The Truth of the two foregoing Operations will thus be proved, *viz.* Multiply the Anſwer by the Parts or Pieces into which the given Number was reduced, and having added the ſeveral Products together, if their Sum be equal to the given Number, the Anſwer is right, otherwiſe not; ſo the Anſwer to the 11th Queſtion was 87720; which is proved as followeth, *viz.*

87720 { Six-pences make——2193
Four-pences make——1462
Two-pences make——731

The Total Sum of them 4386, which was the Sum given to be changed.

The Anſwer to the 11th Queſtion was 798, and 18 Half pence remained, after the Work was ended; now the Truth of the Work may be proved as the former, *viz.*

798

798	Pieces of 13 ½ make	44	17	09
	Pieces of 12 make	39	18	00
	Pieces of 9 make	29	18	06
	Pieces of 6 make	19	19	00
	Pieces of 4	12	06	00
and 18 Half-pence, or 9*d.* remain		00	00	09
	The Total Sum of them	148	00	00

which Total Sum is equal to the Number that was firſt given to be changed, and therefore the Operation was rightly performed.

Reduction of Troy-weight.

We come now to give the Learner a few Examples in *Troy*-weight; in Working whereof he muſt be mindful of the Table of *Troy*-weight delivered in the ſecond Chapter of this Book.

Queſt. 13. In 482 *l.* 7 *oz.* 13 *p.w.* 21 *gr.* how many Grains?

Multiply by 12, by 20, and by 24, taking in the Figures ſtanding in the ſeveral Denominations, according to the Direction given in the Seventh Rule of this Chapter, and you will find the Product to be 2780013 Grains, which is the Number required, or Anſwer to the Queſtion. See the whole Work, as in the Margin:

l.	*oz.*	*p.w.*	*gr.*
482	7	13	21
12			
971			
482			
5791	*Ounces*		
20			
115833	*Penny-weights*		
24			
463333			
231668			
Fac. 2780013			

Queſt. 14. 2780013 Grains, I demand how many Pounds, Ounces, Penny-weights, and Grains?

This is but the foregoing Queſtion inverted, and is reſolved by dividing by 24, by 20, and by 12, and the Anſwer is 482 *l.* 7 *oz.* 13 *p.w.* 21 *gr.*

```
                  2|0         12)
24) 2780013  (11583|3  (5791  (482 l.
    ....       ....     .
    24         10       48
    --         --       --
    38         15       99
    24         14       96
    --         --       --
    140        18       31
    120        18       24
    ---        --       --
     200        3 Rem. 7 Ounces.
     192        2
     ---        --
      81   Rem.  13 Penny-weights.
      72
      --                l.  oz.  p. w.  gr.
       93               482  7    13    21
       72
       --
```

Remain 21 Grains.

Queſt. 15. A Merchant ſent to a Goldſmith 16 Ingots of Silver, each containing in Weight 2 *l.* 8 *oz.* and ordered it to be made into Bowls of 2 *l.* 8 *oz.* *per* Bowl, and Tankards of 1 *l.* 6 *oz.* *per* Piece, and Salts of 10 *oz.* 10 *p. w.* *per* Salt, and Spoons of 1 *oz.* 18 *p. w.* *per* Spoon, and of each an equal Number; I deſire to know how many of each Sort he muſt make?

The Queſtion is of the ſame Nature with the 11th and 12th Queſtion foregoing, and may be anſwered after the ſame Method, *viz.* Firſt, add the Weight of the ſeveral Veſſels, into which the Silver is to be made, into one Sum, and reduce them to one Denomination, and they make 1248 Penny weights; then reduce the Weight of the Ingot into the ſame Denomination, *viz.* Penny-weights, and it makes 560 Penny-weights, and multiply them by the Number of Ingots, *viz.* 16, and the Product will give you the Weight of the 16 Ingots, *viz.* 8960; then divide the Product by the Weight of the Veſſels, *viz.* 1248, and the Quotient giveth you the Anſwer to the Queſtion, *viz.* 7, and 224 *w.* remaineth over and above.

l. *oz.*
2 4
12

28
20

560 Penny-weights
16 Ingots

3360
560

8960
1248) 8960 (7 Veſſels of each
8736

Rem. 234 Penny-weights.

	l.	*oz.*	*p.w.*
	2	08	00
	1	06	00
	0	10	10
	0	01	18
Sum	5	02	08

12

62
20

1248

The Proof of the Work as followeth, viz.

		lb.	*oz.*	*p.w.*				
7	Bowls of	2	08	00 *per* Bowl is		18	08	00
	Tank. of	1	06	00 *per* Tank. is		10	06	00
	Salts of	0	10	10 *per* Salt, is		06	01	10
	Spoons of	0	02	18 *per* Spoon, is		10	01	06
						37	04	09

So that you ſee the Sum of the Weight of each Veſſel, together with the Remainder, is 37 *lb.* 4 *oz.* which is equal to the Weight of the 16 Ingots delivered. For, if 37 *lb.* 4 *oz.* be reduced to Penny-weights, it makes 8960.

Reduction of Avoirdupoiſe-weight.

In reducing Avoirdupoiſe-weight, the Learner muſt have Recourſe to the Table of Avoirdupoiſe-weight, deliver'd in the ſecond Chapter.

Queſt. 16. In 47 *C.* 1 *qr.* 20 *lb.* how many Ounces? Multiply by 4, by 28, and 16, and the laſt Product will be the Anſwer, *viz.* 84992 Ounces. See the Margin:

```
 C.   qr.  lb.
 47    1   20
  4
 ----
 189 qrs.
  28
 ----
 1512
 380
 ----
 3212 lb.
   16
 ----
 31172
 5312
 ----
Facit 84992 Oun.
```

Queſt. 17. In 84992 Ounces, I demand how many C *qrs. lb. oz.*

This is the foregoing Queſtion inverted, and will be reſolved, if you divide 16 by 28, and by 4, and the Anſwer is 47 *C.* 1 *qr.* 20 *lb.* equal to the given Number in the foregoing Queſtion.

```
          28)     4)    C.  qr.  lb.  oz.
16) 84992 (5312 (189   47   1    20   00
    ....    ...   ..
     80      28    16
    ----    ----  ----
     49     251    29
     48     224    28
    ----    ----  ----
     19     272 qr. 1
     16     252
    ----    ----
     32      20 Pounds.
     32
     (0)
```

Queſt. 18. In 45 Tuns of Wine, how many Gallons? Multiply by 4, and by 63, and the Product is 11349 Gallons for the Anſwer.

$$\begin{array}{rr}
 & 45 \\
 & 4 \\
\hline
 & 180 \\
 & 63 \\
\hline
 & 540 \\
 & 1080 \\
\hline
\textit{Facit} & 11340
\end{array}$$

Queſt. 19. In 34 Rundlets of Wine, each containing 18 Gallons, I demand how many Hogſheads?

Firſt, find how many Gallons are in the 34 Rundlets, which you may do, if you multiply 34 by 18, the Content of a Rundlet, and the Product is 612 Gallons; which you may reduce into Hogſheads, if you divide them by 63 and the Quotient will be 2 Hogſheads, and 45 Gallons. See the Work:

$$\begin{array}{rl}
34 & \\
18 & \\
\hline
272 & \\
34 & \\
\hline
63)\ 612 & (9\ \textit{hhds.} \\
567 & \textit{Facit}\ 9\ \textit{hhds.}\ 45\ \textit{Gal.} \\
\hline
\end{array}$$

Remain 45 *Gallons.*

Q. 20. In 12 Tuns, how many Rundlets of 14 Gallon *per* Rundlet?

Reduce your Tuns into Gallons, and divide them by 14, the Gallons in a Rundlet, and the Quotient, 216, is your Anſwer. See the following:

12
4

48
63

144
288

14) 3024 (216 Rundlets.

28

22
14

84
84

(0) *Facit* 216 Rundlets.

Reduction of Long-meaſure.

Queſt. 21. I demand how many Furlongs. Poles, Inches, and Barley-corns will reach from *London* to *York*, it being accounted 151 Miles?

151 Miles
8 Furlongs

1208 Furlongs
40 Poles in a Furlong

48320 Poles
10 Half-yards in a Pole

483200 Half-yards
18 Inches in a Half yard

3865600
483200

8697600 Inches
3 Barley-corns in 1 Inch,

Facit 26092800 Barley-corns in 151 Miles.

Queſt. 22. The Circumference of the Earth, as all other Circles are, is divided into 360 Degrees, and each Degree into 60 Minutes, which uuon the Superficies of the Earth, are equal to 60 Miles; now I demand how many Miles, Furlongs, Perches, Yards, Feet, and Barley-corns, will reach round the Globe of the Earth.

360 Degrees
60 Minutes or Miles in a Degree

21600 Miles upon the Earth
8 Furlongs in a Mile

172800 Furlongs upon the Earth
40 Perches in a Furlong

6912000 Poles or Perches about the Earth
11 Half-yards in a Perch

6912000
6912000

76032000 Half-yards upon the Earth

38016000 Yards, *viz.* the Half-yards
3 divided by 2

114048000 Feet about the Earth
12 Inches in a Foot

228026000
114048000

1368576000 Inches about the Earth
3 Barley-corns in an Inch.

Fac. 4105728000

And ſo many will reach round the World, the whole being about 21600 Miles; ſo that, if any Perſon were to go round, and go 15 Miles every Day, he would go the whole Circumference in 1140 Days; which is 3 Years, 11 Months, and 15 Days.

Reduction of Time.

Queſt. 23. In 28 Years, 24 Weeks, 4 Days, 16 Hours, 30 Minutes, how many Minutes?

Years	*Weeks*	*Days*	*Hours*	*Minutes.*
28	24	4	16	30

52 Weeks in a Year

60
142

1480 Weeks
7

10364 Days
24

41462
20729

248752 Hours
60

14925150 Minutes.

Note, That in reſolving the laſt Queſtion after the Method expreſſed, there are loſt in every Year 30 Hours. For the Year conſiſteth of 365 Days and 6 Hours; but, by multiplying the Year by 52 Weeks, which is 364 Days, you loſe 1 Day and 6 Hours every Year; wherefore, to find an exact Anſwer, bring the odd Weeks, Days, and Hours into Hours, and then multiply the Years by the Number of Hours in the Year, *viz.* 8766, and to the Product add the Hours contained in the odd Time, and you have the exact Time in Hours, which bring into Minutes, as before. See the laſt Queſtion thus reſolved:

Weeks. *Days.* *Hours.*
24 4 16
7

172
24

694
345

4144 Hours

Days. *Hours.*
365 6
24

1466
730

8766 Hours in a Year.

28
8766

172
172
197
228

249592 Hours.
60

14975520 Minutes in 28 Years.

So you ſee that according to the Method firſt uſed to reſolve this Queſtion, the Hours contained in the given Time are 248752; but, according to the laſt, beſt, or trueſt Method, they are 249592, which exceeds the former by 840 Hours.

But, for moſt Occaſions, it will be ſufficient to multiply the given Years by 365, and to the Product add the Days in the odd Time, if there be any; and then there will be only a Loſs of 9 Hours in every Year, which may be ſupplied by taking a fourth Part of the given Years, and adding it to the contained Days, and you have your Deſire.

Queſt. 24. In 438657540 Minutes, how many Years? *Facit* 834 Years, 4 Days, 19 Hours.

```
                  8766)       Years   Days   Hours.
6|0) 43865754|0 (7310959    (834     4      19
     ......         ..

     42           70128
     ——           —————
     18            29815
     18            26298
     ——            —————
      6             35179
      6             35064
     ———            ——————
      57          24) 115 (4 Days
      54               96
     ———              ———
       35          Rem. (9) Hours.
       30
      ———
        54
        54
       ———
        (0)
```

Queſt. 25. I deſire to know how many Hours and Minutes it is ſince the Birth of our Saviour Jeſus, being accounted 1750 Years?

This Queſtion is of the ſame Nature with the 24th foregoing, and after the ſame Manner is reſolved, *viz.* multiply the given Number of Years by 8766, and the Product is 15314202 Hours, and that by 60, and the Product is 918452120 Minutes. See the Work:

```
              1750
              8766
            ——————
             10500
            10500
           12250
          13000
        ————————
      14340500 Hours in 1750 Years.
            60
      ———————————
      860430000 Minutes.
```

Note, That, as Multiplication and Diviſion do interchangeably prove each other, ſo Reduction deſcending and aſcending prove each other by inverting the Queſtion, as the 13th and 14th; and likewiſe the 16th and 17th Queſtions foregoing, by Inverſion, do interchangeably prove each-other. The like may be performed for the Proof of any Queſtion in Reduction whatſoever.

CHAP. IX.

Of Comparative Arithmetick: viz. *The Relation of Numbers one to another.*

COmparative Arithmetick is that which is wrought by Numbers, as they are conſidered to have Relation one to another, and this conſiſts either in Quantity or Quality. See *Boetius*'s Arithm. I. *cap.* 21.

2. Relation of Numbers in Quantity is the Reference or Reſpect the Numbers themſelves have one to another, where the Terms of Numbers propounded are always two, the firſt called the Antecedent, and the other the Conſequent. See *Wingate*'s Arithm.

3. The Relation of Numbers in Quantity conſiſts in the Differences, or in the Rate or Reaſon that is found betwixt the Terms propounded, the Difference of two Numbers being the Remainder found by Subtraction, according to *Alſtead*; but the Rate or Reaſon betwixt two Numbers is the Quotient; of the Antecedent divided by the Conſequent; ſo 21 and 7 being given, the Difference betwixt them will be found to be 14, but the Rate or Reaſon that is betwixt 21 and 7 will be found to be triple Reaſon, for 21 divided by 7, quotes 3, the Reaſon or Rate.

4. The Relation of Numbers in Quality, otherwiſe called Proportion, is the Reference or Reſpect that the Reaſon of Numbers have one to another; therefore the Terms given ought to be more than two. Now the Proportion or Reaſon between Numbers relating one to another is either Arithmetical or Geometrical.

5. Arithmetical Proportion is, when divers Numbers differ one from another by equal Reaſon, that is, have equal Difference.

So this Rank of Numbers, 3, 5, 7, 9, 11, 13, 15, 17, differ by equal Reaſon, *viz.* by 2, as you may prove.

6. In a Rank of Numbers that differ by Arithmetical Proportion, the Sum of the Firſt and laſt Term being multiplied by by half the Number of Terms, the Product is the total Sum of all the Terms.

Or, if you multiply the Number of the Terms by the half Sum of the firſt and laſt Terms, the Product is the total Sum of all their Terms.

So in the former Progreſſion given, 3 and 17 are 20, which multiplied by 4, *viz.* half the Number of Terms, the Product gives 80, the Sum of all the Terms; or multiply 8, the Number of Terms by 10, half the Sum of the firſt and laſt Term, and the Product gives 80, as before.

So alſo, 21, 18, 15, 12, 9, 6, 3, being given, the Sum of all the Terms will be found to be 84; for here the Number of the Terms is 7, and the Sum of the firſt and laſt, *viz.* 21 and 3, is 24, half whereof, *viz.* 12, multiplied by 7, produceth 84, the Sum of the Terms ſought.

7. In three Numbers that differ by Arithmetical Proportion, the Double of the Mean, or middle Number, is equal to the Sum of the Extreams.

So, 9, 12, and 15, being given, the Double of the Mean 12, *viz.* 24, is equal to the Sum of the two Extreams, 9, and 15.

8. Four Numbers that differ by Arithmetical Proportion (either contained or interrupted) the Sum of the two Means is equal to the Sum of the two Extreams.

So, 9, 12, 18, 21, being given, the Sum of 12 and 18 will be equal to the Sum of 9 and 21, *viz.* 30; alſo 6, 8, 14, 16, being given, the Sum of 8 and 14 is equal to the Sum of 6, and 16, *viz.* 22, *&c.* See *Wingate*'s Arithm. c. 35.

9. Geometrical Proportion, by ſome called Geometrical Progreſſion, is when divers Numbers differ, according to right Reaſon.

So, 1, 2, 4, 8, 19, 32, 64, *&c.* differ by double Reaſon; and 3, 9, 27, 81, 243, 729 differ by triple Reaſon; 4, 16, 64, 256, *&c.* differ by quadruple Reaſon, *&c.*

10. In any Number that increaſes, by Geometrical Proportion, if you multiply the laſt Term by the Quotient of any one of the Terms divided by another of the Terms, which, being leſs, is next unto it, and, having deducted or ſubtracted the firſt Term out of that Product, divide the Remainder by a Number that is an Unit leſs than the ſaid Quotient, the laſt Quote will be the Sum of all the Terms.

So, 1, 2, 4, 8, 16, 32, 64, being given, firſt I take one of the Terms, *viz.* 8, and divide it by the Term which is leſs, and next to it, *viz.* by 4, and the Quotient is 2, by which multiply the laſt Term by 64, and the Product is 128; from whence I ſubtract the firſt Term, *viz.* 1, and the remainder is 127, which Dividend by the Quotient 2, and made leſs 1; *viz.* 1, the Quote is 127, for the Sum of all given Terms, as by the Work in the Margin.

```
           64
    4)  8  (2
   ------------
          128
            1
   ------------
    1)  127 (127
```

So, if 4, 16, 64, 256, 1024, were given, the Sum of all the Terms will be found to be 1364. For firſt I divide 64, one of the Terms, by the next leſſer Term, and the Quotient is 4, by which I multiply the laſt Term 1024, and it produceth 4096; from whence I ſubtract the firſt Term 4, and the Remainder is 4092, which I divide by the Quote leſs by 1, *viz.* 3, and the Quotient 13614, for the total Sum of all the Terms, as *per* Margin.

```
             1024
      16) 64 (4
     ------------
             4096
                4
     ------------
   3) 4092 (13614
```

11. Three Geometrical Proportionals being given, the Square of the Mean is equal to the Rectangle, or Product of the Extreams.

So, 8, 16, 32, being given, the Square of the Mean, *viz.* 16, is 256, which is equal to the Product of the Extreams 8 and 32, for 8 times 32 is equal to 256.

12. Of four Geometrical Proportionable Numbers given, the Product of the two Means is equal to the Product of the two Extreams.

So, 8, 16, 32, 42, being given, I ſay, that the Product of the two Means, *viz.* 16 times 32, which is 512, is equal to 8 times 64, the Product of the Extreams.

Alſo if 3, 9, 21, 63, were given, which are interrupted, I ſay, 9 times 21 is equal to 3 times 63, which is equal to 189.

From hence ariſes that precious Gem in Arithmetick, which, for the Excellency thereof, is called the Golden Rule, or Rule of Three.

CHAP. X.

Single Rule of Three Direct.

1. THE Rule of Three, not undeſervedly called the Golden Rule, is that by which we find out a fourth Number in Proportion unto three given Numbers, ſo as the fourth Number that is ſought may bear the ſame Rate, Reaſon, and Proportion to the third given Number, as the ſecond doth to the firſt, from whence it is called the Rule of Proportion.

2. Four Numbers are ſaid to be proportional, when the firſt containeth, or is contained by the ſecond, as often as the third containeth, or is contained by the fourth. Vide *Wingate*'s Arith. Chap. 8. Sect. 4.

So theſe Numbers are ſaid to be Proportionals, *viz.* 3, 6, 9, 18, for as often as the firſt Number is contained in the ſecond, ſo often is the third contained in the fourth, *viz.* twice. Alſo 9, 3, 15, 5, are ſaid to be Proportionals; for, as often as the firſt Number containeth the ſecond, ſo often the third Number containeth the fourth, *viz.* 3 times.

3. The Rule of Three is either Simple or Compound.

4. The Simple, or Single Rule of Three, conſiſteth of 4 Numbers, that is to ſay, it hath 3 Numbers given to find out a fourth, and this is either Direct or Inverſe. Vide *Alſted. Math.* Lib. ii. c. 13.

5. The Single Rule of Three Direct, is when the Proportion of the firſt Term is to the ſecond, as the third is to the fourth; or when it is required that the Number ſought, *viz.* the fourth Number, muſt have the ſame Proportion to the ſecond, as the third hath to the firſt.

6. In the Rule of Three, the greateſt Difficulty is to diſcover the Order of the 3 Terms of the Queſtion, propounded,

pounded, *viz.* which is the firſt, ſecond, and third; which that you may underſtand, obſerve, that, of the three given Numbers, two always are of one Kind, and the other is of the ſame Kind with the proportional Number that is ſought; as in this Queſtion, *viz.* If 4 Yards of Cloth coſt 12 Shillings, what will 6 Yards coſt at that Rate? Here the two Numbers of one Kind are 4 and 6, *viz.* they both ſignify ſo many Yards, and 12*s.* is the ſame Kind with the Number ſought, for the Price of ſix Yards is ſought.

Again obſerve, That of the three given Numbers, thoſe two that are of the ſame Kind, one of them muſt be the firſt, and the other the third, and that, which is of the ſame Kind with the Number ſought, muſt be the ſecond Number in the Rule of Three; and that you may know which of the ſaid Numbers to make your firſt, and which your third, know this, that to one of theſe two Numbers there is always affixed a Demand, and that Number, upon which the Demand lies, muſt always be reckoned the third Number. As, in the forementioned Queſtion, the Demand is affixed to the Number 6, for it is demanded, What 6 Yards will coſt? And therefore 6 muſt be the third Number, and 4, which is of the ſame Denomination or Kind with it, muſt be the firſt, and conſequently the Number 12 muſt be the ſecond; and then the Numbers, being placed in the fore-mentioned Order, will ſtand as followeth, *viz.*

Yards	*s.*	Yards
4	12	6

7. The next Thing is, to find out the fourth Number in Proportion; which that you may do, multiply the ſecond Number by the third, and divide the Product thereof by the firſt; or (which is all one) multiply the third Term, or Number, by the ſecond, and divide the Product thereof by the firſt, and the Quotient thence ariſing is the fourth Number in a direct Proportion, and is the Number ſought, or Anſwer to the Queſtion, and is of the ſame Denomination that the ſecond Number is of. As thus, Let the ſame Queſtion be again repeated, *viz.* If 4 Yards of Cloth coſt 12 Shillings, what will 6 Yards coſt?

Having placed your Numbers according to the ſixth Rule of this Chapter foregoing, I multiply the ſecond Number 12, by the third Number 6, and the Product is 72; which Product I divide by the firſt Number 4, and the Quotient thence ariſing is 18, which is the fourth Proportional or Number ſought, *viz.* 18 Shillings, becauſe the ſecond Number is Shillings, which is the Price of 6 Yards, as was required by the Queſtion. See the Work following.

	yds	*s.*	yds	*s.*
If	4	12	6	18

$$\begin{array}{r} 12 \\ 6 \\ \hline 4)\ 72\ (18\ \text{Shillings} \\ 4 \\ \hline 32 \\ 32 \\ \hline (0) \end{array}$$

Queſt. 2. Another Queſtion may be this, *viz.* If 7 C. of Pepper coſt 21 *l.* how much will 16 C. coſt at that Rate?

To reſolve this Queſtion, I conſider that (according to the 6th Rule of this Chapter) the Terms of Numbers ought to be placed thus, *viz.* the Demand lying upon 16 *C.* it muſt be the third Number, and that of the ſame Kind with it muſt be the firſt, *viz.* 7 *C.* and 21 *l.* being of the ſame Kind with the Number ſought, muſt be the ſecond Number in this Queſtion; then I proceed according to the 7th Rule, and multiply the ſecond Number by the third, *viz.* 21 by 16, and the Product is 336, which I divide by the firſt Number 7, and the Quotient is 48 *l.* which is the Value of 16 *C.* of Pepper, at the Rate of 21 *l.* for 7 *C.* See the Work following.

C. *l.* C.
7 21 16
16

126
21

7) 336 (48 *l.*

28

56
56 *Facit* 48*l.*

0

8. If when you have divided the Product of the 2d and 3d Numbers by the firſt, any Thing remain after Diviſion is ended, ſuch Remainder may be multiplied by the Parts of the next inferior Denomination, that are equal to an Unit, or Integer, of the ſecond Number in the Queſtion, and, the Product thereof, being divided by the firſt Number in the Queſtion, the Quotient is of the ſame Denomination with the Parts by which you multiplied the Remainder, and is Part of the 4th Number which is ſought. And further-more, if any Thing remain, after this laſt Diviſion is ended, multiply it by the Parts of the next inferior Denomination equal to the Unit of the laſt Quotient, and divide the Product by the ſame Diviſor, *viz.* The firſt Number in the Queſtion, and the Quotient is of the ſame Denomination with your Multiplier; follow this Method, until you have reduced your Remainder into the loweſt Denomination, *&c.* An Example or two will make this Rule very plain, which may be the following.

Queſt. 3. If 13 Yards of Velvet, *&c.* coſt 21 *l.* what will 27 Yards of the ſame coſt at that Rate?

Having ordered and wrought my Numbers, according to the 6th and 7th Rules of this Chapter, I find the Quotient to be 43 *l.* and there is a Remainder of 8, ſo that I conclude the Price of 27 Yards to be more than 43 *l.* and, to the Intent that I may know how much more, I work according to the foregoing Rule, *viz.* I multiply the ſaid Remainder 8 by 20, becauſe the ſecond Number in the Queſtion was Pounds, and the Product is 160, which being divided by the firſt Number, *viz.* 13, it quotes 12, which are 12 Shillings; and there is yet a Remainder of 4, which I multiply by 12 Pence, becauſe the laſt Quotient was Shillings, and the Product is 48, which I divide by 13, the firſt Number, and the Quotient is 3 *d.* and yet there remaineth 9, which I multiply by 4 Farthings, and the Product is 36, which I divide by 13 again, and it Quotes 2 Farthings; and there is yet a Remaider of 10, which, becauſe it cometh not to the Value of a Farthing, may be neglected, or rather ſet after the 2 Farthings over the Diviſor, with a Line between them; and then, by the 21ſt and 22d Definitions of the firſt Chapter of this Book, it will be $\frac{10}{13}$ of a Farthing; ſo that I conclude, that if 13 Yards of Velvet coſt 21 *l.* 27 Yards of the ſame will coſt 43 *l.* 12 *s.* $2\frac{10}{12}$ *qrs.* which Fraction is 10 Thirteens of a Farthing. See the Operation as followeth:

	Yds	*l.*	Yds.
If	13	21	27

27
147
42
13) 567 (43
52
47
39
Remain 8
Multiply 20
13) 160 (12 *s.*
13
30
26
Remain 4
Multiply 12
13) 48 (3 *d.*
39
Remain 9
Multiply 4
13) 36 (2
26
Remain 10

	l.	*s.*	*d.*	*qrs.*
Facit	43	12	3	$2\frac{1}{13}$

Queſt. 4. Another Example may be this following. *viz.* If 14 Pounds of Tobacco coſt 27 *s.* what will 478 Pounds coſt at that Rate?

Work according to the laſt Rule, and you will find it to amount to 46 *l.* 1 *s.* 10 *d.* 1$\frac{2}{14}$ *qrs.* and, by the 5th Rule of the 8th Chapter, 921 *s.* may be reduced to 46 *l.* 1 s. So that the whole will be 46*l.* 1 *s.* 10 *d.* 1$\frac{2}{14}$ The Work followeth :

lb. *s.* *lb.*
If 14 27 478
27

3346
956

2|0
14) 12906 (92|1

126 8

30 12
28 12

26 (1) *s.*
14

Remain (12)
Multiply 12

24
12

14) 144 10*d.*

14

Remain (4)
Multiply 4
14) 16) (1$\frac{2}{14}$
14

Remain 2
l. *s.* *d.* *qrs.*
Facit 46 1 10 1$\frac{2}{14}$

9. In the Rule of Three it many times happens, that although the firſt and third Numbers be of one Kind, as both Money, Weight, Meaſure, *&c.* yet they may not be of one Denomination, or perhaps they may both conſiſt of many Denominations; in which Caſe you are to reduce both Numbers to one Denomination; and likewiſe your ſecond Number, if it conſiſts at any Time of divers Denominations it muſt be reduced to the leaſt Name mentioned, or lower if you pleaſe; which being done, multiply the ſecond and third together, and divide by the firſt, as is directed in the 7th Rule of this Chapter.

And note, that always the Anſwer to the Queſtion is in the ſame Denomination that your ſecond Number is of, or is reduced to, as was hinted before.

Queſt. 5. If 15 Ounces of Silver be worth 3 *l.* 15 *s.* what are 86 Ounces worth at that Rate?

In this Queſtion the Numbers being ordered according to the 6th Rule of this Chapter, the firſt and third Numbers are Ounces, and the ſecond Number is of divers Denominations, *viz.* 3 *l.* 15 *s.* which muſt be reduced to Shillings, and the Shillings multiplied by the third Number, and the Product divided by the firſt, gives you the Anſwer in Shillings, *viz.* 430 Shillings, which are reduced to 21 *l.* 10 *s.*

```
        oz.   l.   s.   oz.
     If 15    3    15   86.
              20
           -------
              75
              86
           -------
             450
            600
          -----------
      15) 6450 (43|0
           60    2|0—
          -------21 l. 10s.
           45
           45
          -------
           00 Fac. 21 l. 10 s.
```

In reſolving the laſt Queſtion; the Work would have been the ſame, if you had reduced your ſecond Nnmber into Pence, for then the Anſwer would have been 5160 Pence, equal to 21 *l.* 10 *s.* or, if you had reduced the 2d Number into Farthiugs, the Quotient or Anſwer would have been 20640 Farthings equal to the ſame, as you may prove at your Leiſure.

Queſt. 6. If 8 *lb.* of Pepper coſt 4 *s.* 8*d.* what will 7 *C.* 3 *qrs.* 14 *lb.* coſt?

In this Queſtion the 1ſt Number is 8 *lb.* and the 3d is 7 *C.* 3 *qrs.* 14 *lb.* which muſt be reduced to the ſame Denomination with the 1ſt, *viz.* into Pounds, and the 2d Number muſt be reduced into Pence; then multiply and divide according to the 7th Rule foregoing, and you will find the Anſwer to be 6174 Pence, which is reduced into 25 *l.* 14 *s.* 6*d.*

```
  lb.     s.  d.          C. qrs. lb.
If 8 coſt 4   8 what will 7   3   14 coſt?
          12              4
          --             ---
          56              31
                          28
                         ---
                         252
                         63
                         ---
                         882
                          56 ſecond Number.
                         -----
                         5292
                        4410          12)      2|0  l.  s.  d.
                        -----8) 49392 (6174  (51|4  25  14  6
                                 ...    ..
                                48      60  4
                                ---------------
                                13      17  11
                                 8      21  10
                                ---------------
                                59      54  14 s.
                                56      48
                                ---------
                                32       6 s.
                                ----          l.  s.  d.
                                    0 Fac.   25  14  6
```

Queſt. 7. If 3 *C.* 1 *qr.* 14 *lb.* of Raiſins, coſt 9 *l.* 9 *s.* what will 6 *C.* 3 *qrs.* 20 *lb.* of the ſame coſt?

Here the firſt and third Numbers each conſiſt of diverſe Denominations, but muſt be brought both into one Denomination, *&c.* as you ſee in the Operation that followeth; the Anſwer is reduced into 19 *l.* 8 *s.*

```
     C.  qr.  lb.          l.  s.               C.  qrs.  lb.
If   3    1   14 coſt      9   9 what will      6    3    20 coſt?
     4                    20                    4
   -----                 ----                 -----
    13                   189                   27
    28                                         28
   -----                                      -----
   108                                        216
    27                                         56
   -----                                      -----
   378 Pounds                                 776 Pounds
                                              189 Second Numb.
                                             ------
                                             6984
                                            6208
                                            776
                                            --------2|3    l.    s.
                                    378) 146664 (38|8   19    8
                                         ....       2
                                         1134      ----
                                         -----      18
                                          3326      18
                                          3024     ----
                                         -----       8
                                           3024
                                           3024
                             Fac. 18 l. 1s.------
                                              0
```

Queſt. 8. If in 4 Weeks I ſpend 13 *s.* 4 *d.* how long will 53 *l.* 6 *s.* laſt me at that Rate?

Anſ. 2238 Days, equal to 6 Years, 48 Days. See the Work:

If

s. *d.* *w.* *l.* *s.*
If 13 4 require 4 what will 53 6 coſt?
12 7 20
30 28 Days 1066
13 12
106 2132
1066
12792 Pence
28 Second Number
102336
25584
(365)
16|0) 35817|6 (2238 (6 Years
. . . . 2190
32
Rem. 48 Days
38
32
61 Ye. Days
48 *Facit* 9 48$\frac{86}{100}$
137
128
Remain 9

Queſt. 9. Suppoſe the yearly Rent of a Houſe, a yearly Penſion, or Wages, be 73 *l.* I deſire to know how much it is *per* Day?

Here you are to bring the Year into Days, and ſay, if 365 Days require 73 *l.* what will one Day require?

Now when you come to multiply 73 by 1, the Product is the ſame; for 1 neither multiplieth nor divideth, and 73 cannot be divided by 365, becauſe the Diviſor is bigger that the Divident; wherefore bring the 73 *l.* into Shillings, and they make 1460, which divide by the firſt

Number 365, and the Quotient is 4 *s.* for the Anſwer: As you ſee in the Work:

```
        Days.    l.    Day.
        If 365   73     1
                 20
        ________________
     365) 1460 (4 s.
          1460
          ____ Fac. 4 s. per Day.
            0
```

Queſt. 10. A Merchant bought 14 Pieces of Broad Cloth, each Piece containing 28 Yards, for which he gave after the Rate of 13 *s.* 6 *d.* $\frac{1}{2}$ *per Yard*; now I deſire to know how much he gave for the 14 Pieces at that Rate?

Firſt, find out how many Yards are in the 14 Pieces, which you will do, if you multiply the 14 Pieces by 28, the Number of Yards in a Piece, and it makes 392; then ſay, If a Yard coſt 13 *s.* 6 *d.* $\frac{1}{2}$, what will 392 Yards coſt? Work as followeth, and the Anſwer you will find to be 127400 Half-pence, which, reduced, make 265 *l.* 8 *s.* 4 *d.* For, after you have multiplied your ſecond and third Numbers together, the Product is 127400, which according to the ſeventh Rule, ſhould be divided by the firſt Number; but the firſt Number is 1, which neither multiplieth nor divideth, and therefore the Quotient or 4th Number is the ſame with the Product of the ſecond and third; which is in Half-pence, becauſe the ſecond Number was ſo reduced. See the Work as followeth:

28
14

112
28

392 Yards in the 14 Pieces.

Yd. s. d. Yds.
If 1 coſt 13 $6\frac{1}{2}$, what will 392 coſt?
12 325

32 1960
13 784
1176

162 2|0
2 24) 127400 (530|8 (265 *l.*

Half-pence 325 120 4

74 13
72 12

200 10
192 10

8 8 Shil.

l. *s.* *d.* Remain 8 Half-p. or 4*d.*
Facit 265 8 4

Queſt. 11. A Draper bought 420 Yards of Broad-cloth, and gave for it after the Rate of 14*s.* 10*d* $\frac{3}{4}$ *per* Ell *Engliſh*, now I demand how much he paid for the whole after that Rate?

Bring your Ells into Quarters, and your given Yards into Quarters; the Ell is 5 Quarters, and in 420 Yards are 1680 Quarters; then ſay, if 5 Quarters coſt 14*s.* 10*d.* $\frac{3}{4}$, or 715 Farthings, what will 1680 Quarters coſt?
Facit 250 *l.* 5 *s.* See the Operation:

```
           Ells                      Yards
             1                        420
             5                          4
           ----                     ------
             5                       1680
      qrs.    s.     d.
   If  5      14     10¾             1680
              12                      715
            ------                 --------
              28                      8400
              15                     1680
            -----                  11760
             178d.               -------- 96|0
               4            5)1201200(240240(250l.
            -----              .....      ...
           715 qrs.            10         192
                              -----      -----
                               20         482
                               20         480
                              ------     ------
                                 12 rem.    240 qrs. or 5s.
                                 10
                               ------
                                 20
                                 20
          l.   s.  d.          ------
   Facit 250   5   0              0
```

Quæſt. 12. A Draper bought of a Merchant 50 Pieces of Kerſey, each Piece containing 34 Ells, the Ell *Flemiſh* being 3 Quarters of a Yard, to pay after the Rate of 8 *s.* 4 *d.* *per* Ell *Flemiſh*, I demand how much the 50 Pieces coſt him at that Rate?

Firſt find out how many Ells *Flemiſh* are in the 50 Pieces, by multiplying 50 by 34, the Product is 1700, which bring into Quarters by 3, it makes 5100 Quarters, then proceed as in the laſt Queſtion, and the Anſwer you will find to be 102000 Pence, or 425 *l.* See the Operation as followeth:

```
qrs.   s.  d.
If 5   8   4        5100          50
      12             100          34
     ----         --------d.    ------
     100d.      5) 510000 (10200   200
                   5·····          150
                  ----            -----
                    10            1700 Ells Fl.
                    10               3
                   ----           -----
                     0            5100
                      ·
                         (2|0)
                 12) 10200 (850|2 (425 l.
                     96··  8··
                    -----  ----
                      60   5
                      60   4
                     ----  ----
                       0   10
                           10
                          ----
Facit 425 l.                0
```

Queſt. 13. A Goldſmith bought a Wedge of Gold, which weighed 14*lb.* 3 *oz.* 18 *p. w.* for the Sum of 514 *l.* 4 *s.* I demand what it ſtood him in *per* Ounce? *Anſwer*, 60 *s.* or 3 *l.*

```
  l.   oz.   p.w.              l.   s.      oz.
If 14   3     8               514   4        1
   12                           20 Shill.    20
  ----                        ---------    -----
   31                         10284        20 p.w.
   14                             20 p.w.
  ----                        ----- ----- ( |0)
  171 oz.             3428) 205680 (60 (3 l.
   20                       205680  6
  ----                      ------  ---
  3428 p.w.                      0 Facit 60s. or 3 l.
```

Queſt.

```
        Ells                      Yards
          1                        420
          5                          4
        ———                       ————
          5                       1680
     qrs.   s.    d.
If    5     14    10¾             1680
            12                     715
          ————                   ——————
            28                    8400
            15                   1680
          ————                  11760
           178d.                ———————— 96|0
             4           5)1201200(240240(250l.
          ————               .....     ...
           715 qrs.          10        192
                           ————       ————
                             20        482
                             20        480
                           —————     ——————
                               12 rem.   240 qrs. or 5s.
                               10
                             ————
                               20
                               20
      l.   s.  d.            ————
Facit 250  5   0               0
```

Queſt. 12. A Draper bought of a Merchant 50 Pieces of Kerſey, each Piece containing 34 Ells, the Ell *Flemiſh* being 3 Quarters of a Yard, to pay after the Rate of 8 *s.* 4 *d.* *per* Ell *Flemiſh*, I demand how much the 50 Pieces coſt him at that Rate?

Firſt find out how many Ells *Flemiſh* are in the 50 Pieces, by multiplying 50 by 34, the Product is 1700, which bring into Quarters by 3, it makes 5100 Quarters, then proceed as in the laſt Queſtion, and the Anſwer you will find to be 102000 Pence, or 425 *l.* See the Operation as followeth:

```
qrs.   s.  d.
If 5    8  4        5100              50
       12               100           34
                    ---------d.      ----
       100d.     5) 510200 (10200     200
                    5.....            150
                    ---              ----
                    10                1700 Ells Fl.
                    10                   3
                    --               ----
                    0                 5100
                    .      (2|0)
                12) 10200 (850|2 (425 l.
                    96..   8..
                    ----   --
                     60    5
                     60    4
                    ---    --
                      0    10
                           10
                           --
Facit 425 l.                0
```

Quest. 13. A Goldſmith bought a Wedge of Gold, which weighed 14*lb.* 3*oz.* 18 *p. w.* for the Sum of 514*l.* 4*s.* I emand what it ſtood him in *per* Ounce? *Anſwer*, 60*s.* or 3*l.*

```
 l.  oz.  p.w.                 l.  s.        oz.
f 14  3   8                   514  4          1
  12                           20 Shill.     20
 ---                          --------      ---
 31                           10284          20 p.w.
 14                              20 p.w.
 ---                          ------ ------ (6|0)
 171 oz.             3428) 205680 (60 (3l.
  20                       205680  6
 ---                       ------  --
 3428 p.w.                          0 Facit 60s. or 3l.
```

Queſt. 14. A Grocer bought 4 Hogſheads of Sugar, each weighing near 6 *C.* 2 *qrs.* 14 *lb.* which coſt him 2 *l.* 8 *s.* 6*d.* *per C.* I demand the Value of the 4 Hdds, at that Rate?

Firſt, find the Weight of the 4 Hdds, which you may do by reducing the Weight of one of them into Pounds, and multiply them by 4, the Number of Hdds, and they make 2968 *lb.* Then ſay, If 1 *C.* or 112 *lb.* coſt 2 *l.* 8 *s.* 6 *d.* what will 2968 *lb.* coſt? *Facit* 64 *l.* 5 *s.* 3 *d.* As by the Operation.

```
                                        C.    qrs.   lb.
                                        6      2     14
                                        4
                                       ----
                                        26
                                        2
                                       ----
      lb.   l.  s.  d.    lb.          212
If    112   2   8   6     2968          53
            20             582        ----
           ----    ------------------742 lb. in 1 hhd.
            48            5936         7 Hogſheads.
            12           23744------ ------------
          ----          14840      2968 lb. in 4 hds.
           102    ----------------12)        2|0
            48  112) 1727376      (15413)  128|5  (64 l.
          ----         ....           ..      ..
           582        112             12        12
                     ----            ----      ----
                      607              34         8
                      560              24         8
                     ----            ----      ----
                      473             101         5 Shillings.
                      448              96
                     ----            ----
                      257              63
                      224              60
                     ----            ----
                      336               3 Pen.
                      336
                     ----      l.  s.  d.
                        0 Facit 64  5   3
```

Queſt. 15. A Draper bought of a Merchant 8 Packs of Cloth, each containing 4 Parcels, and each Parcel 16 Pieces, and each Piece 26 Yards, and gave after the Rate of 4 *l.* 16 *s.* for 6 Yards; now I deſire to know how much he gave for the Whole? Anſwer 6656 *l.*

Firſt find out how many Yards there were in the 8 Packs, and by the following Work you will find there are 8320 Yards; then ſay, if 6 Yards coſt 4 *l.* 16 *s.* what will 8320 Yards coſt, &c.

```
                                              8 Packs.
                                              4
                                             ----
                                              32 Parcels
                                              10
                                             ----
                                              320 Pieces
                                              26
                                             -----
Yds.   l.    s.   Yds.                        1920
 6     4     16   8320                        640
       20           96                       -----
      ----        -----                       8320 Yds.
       96         49920
                 74880
               ----------2|0
            6) 798720 (13312|0 (6656 l.
                .....    ...
                6        12
               ---      ---
                19       13
                18       12
               ---      ---
                 18       11
                 18       10
                ---      ---
                  7       12
                  6       12
                 ---     ---
                  12      0
                  12
                 --- Facit 6656 l.
                  0
```

By this Time the Learner is, as I ſuppoſe, well exerciſed in the practick and Theoretick of the Rule of Three Direct; but at his Leiſure he may look over the following Queſtions whoſe Anſwers were given, but the Operation purpoſely omitted as a Touchſtone for the Learner, thereby to try his Ability in what hath been deliver'd in the former Rules.

Queſt. 16. If 24 Pound of Raiſins coſt 6 *s.* 6 *d.* what will 18 Frails coſt, each weighing near 3 *qrs.* 18 *lb.* *Anſ.* 24 *l.* 17 *s.* 5 *d.*

Queſt. 17. If an Ounce of Silver be worth 5 Shillings, what is the Price of 14 Ingots, each Ingot weighing 7 *lb.* 5 *oz.* 10 *p.w.* *Anſ.* 313 *l.* 5 *s.*

Queſt. 18. If a Piece of Cloth coſt 10 *l.* 16 *s.* 8 *d.* I demand how many Ells *Eng.* there are in the ſame, which Ell at that Rate is worth 8 *s.* 4 *d.* *Anſ.* 26 Ells *Eng.*

Queſt. 19. A Factor bought 84 Piecs of Stuffs, which coſt ihm in all 537 *l.* 12 *s.* at 5 *s.* 4 *d.* *per* Yard, I demand how many Yards there were in all, and how many Ells *Eng.* were contained in a Piece of the ſame? *Anſ.* 2016 Yards in all, and $19\frac{1}{2}$ Ells of *Eng.* *per* Piece.

Queſt. 20. A Draper bought 242 Yards of Broad-cloth, which coſt him in all 254 *l.* 10 *s.* for 86 Yards, of which he gave after the Rate of 11 *s.* 4 *d.* *per* Yard, I demand how much he gave *per* Yard for the Remainder? *Anſ.* 20 *s.* 9 *d.* $\frac{44}{11}$ *per* Yard.

Queſt. 21. A Factor bought a certain Quantity of Serge and Sallcon which together coſt him 126 *l.* 14 *s.* 10 *d* the Quantity of Serge he bought was 48 Yards, at 4 *s.* 4 *d.* *per* Yard; and for every two Yards of Serge he had 5 Yards of Shalloon; I demand how many Yards of Shalloon he had, and how much the Shalloon coſt him *per* Yard? *Anſ.* 120 Yards of Shalloon at 1 *l.* 15 *s.* 5 *d.* $\frac{15}{06}$ *per* Yard.

Queſt. 22. An Oilman bought three Tuns of Oil, which coſt him 151 *l.* 14 *s.* and ſo it chanced that it leaked out 15 Gallons; but he is minded to ſell it again, ſo that he may be no Loſer by it; I demand how he muſt ſell it *per* Gallon? *Anſ.* at 4 *s.* 6 *d.* $\frac{101}{674}$ *per* Gallon.

Queſt. 23. Bought 9 Packs of Cloth, each Pack containing 12 Cloths, which at 5 *s.* 4 *d.* Ell *Flem.* coſt 1080 *l.* I demand how many Yards there were in each Cloth? *Anſ.* 27 Yards in each Cloth.

Queſt. 24. A Gentleman hath 535 *l. per Ann.* and his Expences are, one Day with another, 18 *s.* 10*d.* 3 *qrs.* I deſire to know how much he layeth up at the Year's End? *Anſ.* 191 *l.* 3 *s* 8 *d.* 1*qr.*

Queſt. 25. A Gentleman expendeth daily one Day with another 27 *s.* 10 *d* $\frac{1}{2}$, and at the Year's End layeth up 340 *l.* I demand how much is his yearly Income? *Anſ.* 848 *l.* 14 *s.* 4*d* $\frac{1}{2}$.

Queſt. 26. If I ſell 24 Yards for 10 *l.* 10 *s.* how many Ells *Flem.* ſhall I ſell for 283 *l.* 17 *s.* 6*d.* at that Rate? *Anſ.* 504 $\frac{1}{2}$ Ells *Flem.*

Queſt. 27. If 100 *l.* in 12 Months gain 6 *l.* Intereſt, how much will 75 *l.* gain in the ſame Time, and at the ſame Rate? *Anſ.* 4 *l.* 10 *s.*

Queſt. 28. If 100 *l.* in 12 Months gain 6 *l.* Intereſt, how much will it gain in 7 Months at that Rate? *Anſ.* 3 *l.* 10*s.*

Queſt. 29. A certain Uſurer put out 73 *l.* for 12 Months, and received Principal and Intereſt 81 *l.* I demand what Rate *per Cent.* he received Intereſt? *Anſ.* 8 *l. per Cent.*

Queſt. 30. A Grocer bought 2 Cheſts of Sugar, the one weigh'd near 18 *C.* 3 *qr.* 14 *lb.* at 2 *l.* 6 *s.* 8 *d. per C.* the other weigh'd near 18 *C.* 3 *qr.* at 4 *d.* $\frac{1}{2}$ *per lb.* which he mingled together; now I deſire to know how much a *C. wt.* of this Mixture is worth. *Anſ.* 2 *l.* 4 *s.* 2 *d.* $\frac{067}{067}$ *qrs.*

Queſt. 31. Two Men, *viz.* *A* and *B* departed both from one Place, the one goes Eaſt, the other Weſt; the one travelleth 4 Miles a Day, and the other 5 Miles a Day, how far are they diſtant the 9th Day after their Departure? *Anſ.* 81 Miles.

Queſt. 32. *A* flying every Day 40 Miles, is purſued the fourth Day after by *B*, poſting 50 Miles a Day; now the Queſtion is, in how many Days, and after how many Miles Travel, will *A* be overtaken?

Anſ. *B* overtakes him in 32 Days, when they have travelled 1600 Miles. See *More*'s *Arithm. cap.* 8. pr. 7.

11. The general Effect of the Rule of Three Direct, is contained in the Definition of the ſame, that is, to find a fourth Number in Proportion, conſiſting of two equal Reaſons; as hath been fully ſhewn in all the foregoing Examples.

By this Time the Learner is, as I ſuppoſe, well exerciſed in the practick and Theoretick of the Rule of Three Direct; but at his Leiſure he may look over the following Queſtions whoſe Anſwers were given, but the Operation purpoſely omitted as a Touchſtone for the Learner, thereby to try his Ability in what hath been deliver'd in the former Rules.

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Queſt. 25. A Gentleman expendeth daily one Day with another 27 *s.* 10 *d* $\frac{1}{2}$, and at the Year's End layeth up 340 *l.* I demand how much is his yearly Income? *Anſ.* 848 *l.* 14 *s.* 4*d* $\frac{1}{2}$.

Queſt. 26. If I ſell 24 Yards for 10 *l.* 10 *s.* how many Ells *Flem.* ſhall I ſell for 283 *l.* 17 *s.* 6*d.* at that Rate? *Anſ.* 504 $\frac{1}{2}$ Ells *Flem.*

Queſt. 27. If 100 *l.* in 12 Months gain 6 *l.* Intereſt, how much will 75 *l.* gain in the ſame Time, and at the ſame Rate? *Anſ.* 4 *l.* 10 *s.*

Queſt. 28. If 100 *l.* in 12 Months gain 6 *l.* Intereſt, how much will it gain in 7 Months at that Rate? *Anſ.* 3 *l.* 10*s.*

Queſt. 29. A certain Uſurer put out 73 *l.* for 12 Months, and received Principal and Intereſt 81 *l.* I demand what Rate *per Cent.* he received Intereſt? *Anſ.* 8 *l. per Cent.*

Queſt. 30. A Grocer bought 2 Cheſts of Sugar, the one weigh'd near 18 *C.* 3 *qr.* 14 *lb.* at 2 *l.* 6 *s.* 8 *d. per C.* the other weigh'd near 18 *C.* 3 *qr.* at 4 *d.* $\frac{1}{2}$ *per lb.* which he mingled together; now I deſire to know how much a *C. wt.* of this Mixture is worth. *Anſ.* 2 *l.* 4 *s.* 2 *d.* $\frac{067}{067}$ *qrs.*

Queſt. 31. Two Men, *viz.* *A* and *B* departed both from one Place, the one goes Eaſt, the other Weſt; the one travelleth 4 Miles a Day, and the other 5 Miles a Day, how far are they diſtant the 9th Day after their Departure? *Anſ.* 81 Miles.

Queſt. 32. *A* flying every Day 40 Miles, is purſued the fourth Day after by *B*, poſting 50 Miles a Day; now the Queſtion is, in how many Days, and after how many Miles Travel, will *A* be overtaken?

Anſ. *B* overtakes him in 32 Days, when they have travelled 1600 Miles. See *More*'s *Arithm. cap.* 8. pr. 7.

11. The general Effect of the Rule of Three Direct, is contained in the Definition of the ſame, that is, to find a fourth Number in Proportion, conſiſting of two equal Reaſons; as hath been fully ſhewn in all the foregoing Examples.

F 5

The ſecond Effect is by the Price or Value of one Thing, to find the Price and Value of many Things of like Kind.

The third Effect is, by the Price or Value of many Things, to find the Price of one; or by the Price of many Things, the ſaid Price being one, to find the Price of many Things of like Kind.

The 4th Effect is, by the Price or Value of many, to find the Price or Value of many Things of like Kind.

The 5th Effect is, thereby to reduce any Number of Monies, Weights, Meaſures, of one Sort into the other, as in the Rules of Reduction contained in the 8th Chapter, foregoing. Examples of its various Effects have been already anſwered.

12. The Rule of Three Direct is thus proved, *viz.* Multiplying the firſt Number by the 4th, (*The Proof of the Rule of Three Direct*) and note the Product; then multiply the 2d Number by the 3d, and if this Product is equal to the Product of the 1ſt and 4th, then the Work is rightly performed, otherwiſe it is erroneous.

So the firſt Queſtion of the Chapter, whoſe Anſwer or 4th Number we found to be 18 *s.* is thus proved, *viz.* the firſt Number is 4, which multiplied by 18, the 4th, produceth 72, and the ſecond and third Numbers are 12 and 6, which multiplied together produce 72, equal to the Product of the 1ſt and 4th, and thereſore I conclude the Work to be rightly performed.

Always obſerving, That if any Thing remain after you have divided the Product of the 2d and third Numbers by the firſt, ſuch Remainder in proving the ſame, muſt be added to the Product of the 1ſt and 4th Numbers, whoſe Sum will be equal to the Product of the ſecond and third, the ſecond Number being of the ſame Denomination with the fourth, and the firſt of the ſame Denomination with the third.

So the fourth Queſtion of this Chapter being again repeated, *viz.* If 14 *lb.* of Tobacco coſt 27 *s.* what will 478 *l.* coſt at that Rate? The Anſwer, or fourth Number was 46 *lb.* 1 *s.* and 10 *d.* 1 *qr.* which is thus proved; *viz.* bringing the 4th Number into Farthings, and it makes 44294, which multiplied by the firſt Number 14, produceth 619488 (the ſecond which remaineth being added thereto) then becauſe I reduce my fourth Number into Farthings, I reduce my ſecond, *viz.* 27 *s.* into Farthings, and they are 1296, which multiplied by the 3d Number 478, their Product is 619488, equal to the Product of the firſt and fourth Numbers. Wherefore I conclude the Operation to be true. This is an infallible Way to prove the Rule of Three Direct, and it is reduced from the 12th Section to the 9th Chapter of this Book.

And thus much for the ineſtimable Rule of Three Direct, the Denomination of which may be ſeen in *Kerſey*'s Appendix to *Wingate*'s Arithm. and in the 7th Chapter of *Oughtred's Clavis Mathematica.*

CHAP. XI.

Single Rule of Three Inverſe.

1. THE Golden Rule, or Rule of Three Inverſe, is when there are 3 Numbers, given to find a 4th in ſuch Proportion to the 3 given Numbers, ſo as the 4th proceeds from the 2d according to the ſame Rate, Reaſon or Proportion, that the firſt proceeds from the Third, or the Proportion is,

As the 4th Number is in Proportion to the 2d, ſo is the 1ſt to the 3d. See *Alſtead Math. l. 2. c.* 14.

So if three Numbers given were 8. 12, and 16, and it were required to find a fourth Number in an inverted Proportion to theſe, I ſay, that as 16, the third Number is the Double of the firſt Term or Number 8, ſo muſt 12, the ſecond Number, be the Double of the 4th; ſo will you find the fourth Term or Number to be 6. And as in the Rule of Three Direct, you multiply the Second and Third together, and divide their Product for a fourth proportionable Number.

2. In the Rule of Three Inverſe, you muſt multiply the ſecond Term by the firſt, or firſt Term by the Second, and divide the Product thereof by the firſt Term, ſo the Quotient will give you the 4th Term ſought in an inverted Proportion. The ſame Order being obſerved in this Rule as in the Rule of Three Direct, for placing and diſpoſing of

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2. In the Rule of Three Inverſe, you muſt multiply the ſecond Term by the firſt, or firſt Term by the Second, and divide the Product thereof by the firſt Term, ſo the Quotient will give you the 4th Term ſought in an inverted Proportion. The ſame Order being obſerved in this Rule as in the Rule of Three Direct, for placing and diſpoſing of the

given Numbers, and after your Numbers are placed in order, that you may know whether your Queſtion be to be reſolved by the Rule Direct or Inverſe, obſerve the general Rule following.

3. When your Queſtion is ſtated, and your Numbers orderly diſpoſed, conſider in the firſt Place, whether the fourth Term or Number ſought, ought to be more or leſs than the ſecond Term; which you may eaſily do: And if it is required to be more, or greater than the ſecond Term, then the leſſer Extream muſt be your Diviſor; but if it requires leſs, then the higheſt Extream muſt be your Diviſor: In this Caſe, the 1ſt and 3d Numbers are called Extreams, in reſpects of the Second, and having found out your Diviſor, you may know whether your Queſtion belong to the Rule Direct or Inverſe; for if the third Term be your Diviſor, then it is Inverſe; but if the 1ſt Term be your Diviſor, then it is a direct Rule. As in the following Queſtions:

Queſt. 1. If 8 Labourers can do a certain Piece of Work in 12 Days, in how many Days will 16 Labourers do the ſame? *Anſw.* in 6 Days.

Having placed the Numbers according to the 6th Rule of the 10th Chapter, I conſider that if 8 Men can finiſh the Work in 12 Days, 16 Men will do it in leſſer, or fewer Days than 12, therefore the biggeſt Extream muſt be the Diviſor, which is 16, and therefore it is the Rule of Three Inverſe; wherefore I multiply the 1ſt and 2d Numbers together, *viz.* 8 by 12, and their Product is 96; which divided by 16, quotes 6 Days for the Anſwer; and in ſo many Days will 16 Labourers perform a Piece of Work, when 8 Men can do it in 12 Days.

Lab.	Days	Lab.
8	12	16
	8	

16) 96 (6 Days
96

0

Facit 6 Days.

Queſt. 2. If when a Meaſure, *viz.* a Peck of Wheat coſt 2 *s.* the Penny-Loaf weighed, according to the Standard Statute or Law of *England*, 8 Ounces, I demand how much it will weigh when the Peck is worth 1*s.* 6*d.* according to the ſame Rate or Proportion? *Anſ.* 10 *oz.* 23 *p.w.* 8 *gr.*

Having placed and reduced the given Numbers according to to the 6th and 9th Rules of the 10th Chapter, I conſider that at 1 *s.* 6 *d.* *per* Peck; the Penny-loaf will weigh more than 2 *s.* *per* Peck; for as the Price decreaſeth, ſo the Weight increaſeth; and as the Price increaſeth, ſo the Weight diminiſhed; wherefore becauſe the firſt Term requires more than the ſecond, the leſſer Extream muſt be the Diviſor, viz. 1 *s.* 6 *d.* or 18 *d.* and having finiſhed the Work, I find the Anſwer to be 10 *oz.* 23 *p.w.* 8 *gr.* Wheat is worth 1 *s.* 6 *d.* according to the given Rate of 8 Ounces, when the Peck is worth two Shillings. The Work is plain in the following Operation:

```
      d.   oz.   d.
   If 24    8    18
       8
   ———— oz. p.w. gr.
   18) 192 (10  13  8  Anſ.
       18
      ————
        12
        22
      ———————p.w.
        240 (13
        18
        ————
         60
         54
        ————
          6
         24
        ————
         144 (8 gr.
         144
        ————
           0
```

Queſt. 3. How many Pieces of Money or Merchandize at 20*s.* per Piece, are to be given or received for 240 Pieces, the Value or Price of every Piece being 12 Shillings? Anſwer 144 Pieces. For if 12*s.* required 240 Pieces, then 20*s.* will require leſs; therefore the bigger Extream muſt be the Diviſor, which is the third Number, &c. See the Work as in the Margin.

s. *pcs.*
If 12 240 20
12
480
240
2|0) 288|0 (144 *pes*
20*s.* *per* pe.
2
8
8
8
8
0

Queſt. 4. How many Yards of 3 Quarters Broad are required to Double, or be equal in Meaſure to 30 Yards, that are 5 Quarters Broad? *Anſwer,* 50 Yards. For ſay, if 3 Quarters will require 30 Yards, long, what Length will 3 Quarters Broad require? Here I conſider that 3 Quarters Broad will require more Yards than 30; for the narrower the Cloth is, the more in Length will go to make equal Meaſure with a broader Piece.

qrs. *long.* *qrs.*
3 30 5
5
3) 150 (50 *yds.*
15
0

Queſt. 5 At the Requeſt of a Friend, I lent him 300 *l* for 12 Months; promiſing to do me the like Courteſy at my Neceſſity; but when I came to requeſt it of him, he could let me have but 150*l.* now I deſire to know how long I may keep this Money to my plenary Satisfaction for my former Kindneſs to my Friend? *Anſwer,* 16 Months. I ſay, if 200 *l.* will require more Time than 12 Months, therefore the leſſer Extream, *viz.* 150, muſt be the Diviſor; multiply and divide, and you will find the 4th inverted Proportionable to be 16, and ſo many Months I ought to keep the 150 *l.* for Satisfaction.

Queſt. 6. If for 24*s.* I have 1200 *lb.* Weight carried 36 Miles, how many Miles ſhall 1800 *lb.* be carried for the ſame? *Anſ.* 24 Miles.

Queſt. 7. If for 40 *s.* I have 1200 *wt.* carried 36 Miles, how many *lb. wt.* ſhall I have carried 24 Miles for the ſame Money? *Anſwer* 1800 *lb. wt.*

Queſt. 8. If 100 Workmen in 12 Days finiſh a Piece of Work or Service, how many Workmen are ſufficient to do the ſame in 3 Days? *Anſw.* 400 Workmen.

Queſt. 9. A Colonel is beſieged in a Town, in which are 1000 Soldiers, with Proviſion of Victuals only for three Months; the Queſtion is, How many of his Soldiers muſt he diſmiſs, that his Victuals may laſt the remaining Soldiers 6 Months? *Anſw.* 500 he muſt keep, and diſmiſs as many.

Queſt. 10 If 20 *l.* worth of Wine is ſufficient for the Ordinary of 100 Men, when the Tun is ſold for 100 *l.* how many Men will the ſame 20 *l.* worth ſuffice when the Tuu is worth 25 *l.* *Anſw.* 125 Men.

Queſt. 11. How much Pluſh is ſufficient for the Cloak, which hath in it 4 Yards of 7 Quarters wide, when the Pluſh is but 3 Quarters wide? *Anſw.* 9½ Yards of Pluſh.

Queſt. 12. How many Yards of Canvas that is Ell-wide will be ſufficient to line 20 Yards of Say, that is 3 Quarters wide? *Anſw.* 12 Yards.

Queſt. 13. How many Yards of Matting that is 2 Feet wide will cover a Floor that is 24 Feet long, and 20 Feet broad? *Anſw.* 140 Feet.

Queſt. 14. A Regiment of Soldiers, conſiſting of 1000, are to have new Coats, and each Coat to contain two Yards two Quarters of Cloth that is 5 Quarters wide, and they are to be lined with Shalloon that is two Quarters wide, I demand how many Yards of Shalloon will line them? *Anſw.* 16666½ Quarters, or 4166¾ Yards.

Queſt. 15. A Meſſenger makes a Journey in 24 Days, when the Day is 12 Hours long: I deſire to know in how many Days he will go the ſame when the Day is 16 Hours long? *Anſw.* in 18 Days.

Queſt. 16. I borrowed of my Friend 60 *l.* for 8 Months, and he hath Occaſion another Time to borrow of me for 12 Months. I deſire to know how much I muſt lend him to make good his former Kindneſs to me? *Anſw.* 42 *l.* 13 *s.* 4 *d.*

4. The general Effect of the Rule of Three Inverſe, is contained in the Definition of the ſame, that is, to find a fourth Term in Reciprocal Proportion inverted to the Proportion given.

The 2d Effect is, by two Pieces, or Value of two ſeveral Pieces of Money or Merchandize known, to find how many Pieces of the one Price is to be given for ſo many of the other. And ſo to reduce and exchange one Sort of Money or Merchandize into another. Or elſe to find the Price unknown of any Piece given to exchange in reciprocal Proportion.

The 3d Effect is, by two different Prices of a Meaſure of Wheat bought or ſold, and the Weight of a Loaf of Bread, made anſwerable to one of the Pieces of the Meaſure given, to find out the Weight of the ſame Loaf anſwerable to the other Price of the ſaid Meaſure given.

Or elſe, by the two ſeveral Weights of the ſame priced Loaf, and the Price of the Meaſure of Wheat anſwerable to one of thoſe Weights given, to find out the other Price of the Meaſure anſwerable to the other Weight of the ſame Loaf.

The 4th Effect is, by two Lengths, and one breadth of two Rectangular Places known, to find out another Breadth unknown. Or, by 2 Breadths, and one Length given, to find out another Length unknown in an inverted Proportion.

The 5th Effect is, by double Time, and a capital Sum of Money borrowed or lent, to find out another capital Sum anſwerable to one of the given Times; or otherwiſe by two capital Sums, and a Time anſwerable to one of them given, to find out a Time anſwerable to the other capital Sum in reciprocal Reaſon.

The 6th Effect is, by two different Weights of Carriage, and the Diſtance of the Place in Miles or Leagues given, to find another Diſtance in Miles anſwerable to the ſame Price of Payment. Or otherwiſe, by two Diſtances in Miles, and the Weight anſwerable to one of the Diſtances in Miles, carried for a certain Price, to find out the Weight anſwerable to the other Diſtance for the ſame Price.

The 7th Effect is, by double Workmen, and the Time anſwerable to one of the Numbers of Workmen given, to find out the Time anſwerable to the other Number of Workmen in the Performance of any Work or Service. Or contrariwiſe, by double Time, and the Workmen anſwerable to one of thoſe Times given, to find out the Number of Workmen anſwerable to the other Time, in the Performance of any Work or Service.

Alſo by a double Price of Proviſion, and the Number of Men, or other Creatures, nouriſhed for a certain Time anſwerable to one of the Prices of Proviſions given, to find out another Number of Men or other Creatures anſwerable to the other Price of the Proviſion for the ſame Time. Or contrariwiſe, by two Numbers of Men, or other Creatures nouriſhed, and one Price of Proviſion anſwerable to one of the Numbers of Creatures given to find out the other Price of the ſame Proviſion anſwerable to the other Number of Creatures, both being ſuppoſed to be nouriſhed for the ſame, *&c.*

To prove the Operation of the Rule of Three Inverſe, multiply the 3d and 4th Terms together, and note their Product; and multiply the 1ſt and 2d together, and if their Product is equal to the Product of the 3d and 4h, then is the Work truly wrought, but if it falleth out otherwiſe, then it is erroneous.

As in the firſt Queſtion of this Chapter, the 3d Number, being multiplied by 6, the 4th Number, the Product is 26, and the Product of 8, the firſt Number, multiplied by 12, and the 2d Number, is 96, equal to the firſt Product, which proves the Work to be right.

And note, That if in Diviſion any Thing remain, ſuch Remainder muſt be added to the Product on the Third and Fourth Terms, and if the Sum be equal to the Product of the firſt and ſecond, the Homogeneal Terms being of one Denomination, the Work is right.

CHAP. XII.

The Double Rule of Three Direct.

WE have already delivered the Rule of Single Proportion, and we come now to lay down the Rules of Plural Proportion.

1. Plural Proportion is, when more Operations in the Rule of Three than one are required before a Solution can be given to the Queſtion propounded; therefore in Queſtions that require Plurality in Proportion, there are always given more than three Numbers.

2. When there are given five Numbers, and a Sixth is required in Proportion thereunto, then the ſixth Proportion is ſaid to be found out by the Double Rule of Three, as in the Queſtion following, *viz.*

If 100 *l.* in 12 Months gain 6 *l.* Intereſt, how much will 75 *l.* gain in 9 Months?

3. Queſtions in the Double Rule of Three, may be reſolved either by 2 Single Rules of Three, or by 1 Single Rule of Three, compounded of the five given Numbers.

4. The Double Rule of Three, is either Direct or elſe Inverſe

5. The Double Rule of Three Direct is when in 5 given Numbers, a ſixth Proportionable may be found out by two Single Rules of Three Direct.

6. The five given Numbers in the Double Rule of Three Direct conſiſt of two Parts, *viz.* 1ſt. A Suppoſition, and 2dly, of a Demand; the Suppoſition is contained in the three firſt or the five given Numbers, and the Demand lies in the two laſt; as in the Example of the ſecond Rule of this Chapter, *viz.* if 100 *l.* in 12 Months gain 6 *l.* Intereſt, what will 75 *l.* gain in 9 Months? Here the Suppoſition is expreſſed in 100, 12, and 6, for it is ſaid, if 100 *l.* in 12 Months gain 6 *l.* Intereſt: And the Demand lieth in 75 and 9, for it is demanded, How much 75 *l.* will gain in 9 Months.

7. When your Queſtion is ſtated, the next Thing will be to diſpoſe of the given Numbers in due Order and Place as a Preparative for Reſolution: Which that you may do, Firſt, Obſerve which of the given Numbers in the Suppoſition is of the ſame Denomination with the Number required, for that muſt be the 2d Number, in the firſt Operation, of the Single Rule of Three, and one of the other Numbers in the Suppoſition, it matters not which, muſt be the firſt Number, and that Number in the Demand, which is of the ſame Denomination with the firſt, muſt be the third Number; which three Numbers being thus

placed, will make one perfect Queſtion in the Single Rule of Three, as in the forementioned Example: For, I conſider, that the Number required in the Queſtion, is in the Intereſt or Gain of 75 *l.* therefore that Number in the Suppoſition which hath the ſame Name, *viz.* 6 *l.* which is the Intereſt or Gain of 100 *l.* muſt be the ſecond Number in the firſt Operation, and either 100 or 12, it matters not which, muſt be the firſt Number; but I will take 100; and then for the 3d Number, I put that Number in the Demand, which hath the ſame Denomination with 100, which is 75; for they both ſignify Pounds Principal, and then the Numbers will ſtand as you ſee in the Margin

100 6 75

But if I had for the firſt Number put the other Number in the Suppoſition, *viz.* 12, which ſignifies 12 Months, then the third Number muſt have been, 9, which is the Number in the demand which hath the ſame Denomination with the firſt, *viz* 9 Months, and they will ſtand in the Margin.

100 9 9

There yet remain two Numbers to be diſpoſed of, and thoſe are one in the Suppoſition, and another in the Demand; that which is of the Suppoſition I place under the firſt of the three Numbers; and the other which is the Demand, I place under the third Number and then two of the Terms in the Suppoſition will ſtand, one over the other, in the firſt Place, and the two Terms in the Demand will ſtand, one over the other, in the third Place, as in the Margin.

112 6 75
12 9
Or thus;
12 6 9
109 75

8. Having diſpoſed or ordered the given Numbers, according to the laſt Rule, we may proceed to a Reſolution; and firſt I work with the three uppermoſt Numbers, which according to the firſt Diſpoſition, are 100, 6, and 75; which is as much as to ſay, if 100 *l.* requires 6 *l.* Intereſt, how much will 75 Pounds require? which by the 3d Rule of the 11th Chapter I find to be direct; and by the 7th and 8th Rule of the 10th Chapter, I find the 4th Proportional Number to be 4 *l.* 10 *s.* ſo that by the foregoing ſingle Queſtion, I have diſcovered how much Intereſt 75 *l.* will gain in 12 Months: the Operation whereof followeth on the left Hand under the Letter A, and having

diſcovered how much it will gain in 12 Months, we may by another Queſtion eaſily diſcover how much it will gain in 9 Months; for this 4th Number, thus found, I put in the Middle between the loweſt Numbers of the 5, after they are placed according to the 7th Rule of this Chapter; and then it will be a ſecond Number in another Queſtion in the Rule of Three. The Numbers being *m.* 12 *l.* 4 *s.* 10 *m.* 9 the firſt and third Numbers being of one Denomination, *viz.* both Months, and may be thus expreſſed: If 12 Months require 40 *l.* 10 *s.* Intereſt, what will 9 Months require? And by the 3d Rule of the 11th Chapter, I find it to be the direct Rule, and by working according to the Directions laid down in the 7th, 8th, and 9th Rules of the 10th Chapter, I find the fourth Proportional Number to the laſt Single Queſtion, to be 3 *l.* 7 *s.* 6*d.* which is the ſixth proportional Number to the 5 given Numbers, and is the Anſwer to the general Queſtion. The Work of the laſt Single Queſtion is expreſſed on the right Side of the Page under the Letter B, as followeth:

```
                        100 | ——6——75
A                        12 |      9                 B
If 100 ——6 ———75            | Then ſay, m.   l.   s.   m.
         75                 |         If 12   4   10   9
         ——                 |                20
         30                 |                ——
         42                 |                90 Shil.
        ———                 |                21
  1|00) 4|50 (4—10          |                ——
          .                 |               180
          4                 |                90
         ——                 |                ——
Rem.     50                 |              1080 Pence
Mult.    20                 |                 9
         ——                 | ———————12) 2|0      l. s. d.
 1|00)  10|00 (100          | 12)9720 (810 (67 (67 (3 7 6
                            |      . .    .
               l.    s.     |   99    72————
         Facit 4    10      |   ——    ——— 7 s.
                            |   12    90
                            |   12    84      l. s. d.
                            |   ——    ——
                            |    0     0 Fac. 3 7 6
```

So that by the foregoing Operation I conclude, that if 100 *l.* in 12 Months gain 6 *l.* Intereſt, 75 *l.* will gain 3 *l.* 7 *s.* 6*d.* in 9 Months, after the ſame Rate.

The Anſwer would have been the ſame if the 5 given Numbers had been ordered according to the ſecond Method, viz. as you ſee in the Margin.

12	6	9
100		75

For firſt, I ſay, if 12 Months gain 9 *l.* what will 9 Months gain? This Queſtion I find to be direct, by the 3d Rule of the 11th Chapter, and by the 7th and 8th Rules of the 10th Chapter, I find the 4th proportional Number to theſe three to be 4 *l.* 10 *s.*

Thus have I found out what is the Intereſt of 100 *l.* for 9 Months, and I am now to find the Intereſt of 75 *l.* for 9 Months, to effect which, I make this 4th Number, found as before, to be my ſecond Number in the next Queſtion, I ſay, if 100 *l.* require 4 *l.* 10 *s.* what will 75 *l.* require? This queſtion I find, by the ſaid 3d Rule of the 11th Chapter, to be direct, and by the ſaid 7th, 8th and 9th Rules of the 10th Chapter, I find the Anſwer to be as before, viz. 3 *l.* 7 *s.* 6 *d.*

The Operations of this Rule in the following Queſtions, are purpoſely omitted, to try the Learner's Capacity.

Queſt. 3. A 3d Example in this Rule may be as followeth, viz A Carrier received 42 Shillings for the Carriage of 300 Weight 150 Miles, I demand how much he ought to receive for the Carriage of 7 C. 3 *qrs.* 4*lb.* 50 Miles at that Rate? *Anſwer* 36*s.* 9*d.*

Queſt. 4 A Regiment of 136 Soldiers eat up 351 Quarters of Wheat in 108 Days, I demand how many Quarters of Wheat 11232 Soldiers will eat in 56 Days at that Rate? *Anſwer* 1404 Quarters.

Queſt. 6. If 50 Acres of Graſs be moved by 34 Men in 28 Days, how many Men will do the ſame Work in 24 Days? *Anſwer* 48.

Queſt. 6. If 48 Buſhels of Corn, or other Seed, yield 576 Buſhels in a Year, how much will 240 Buſhels yield in 6 Years at that Rate? That is to ſay, if there were ſowed 240 Buſhels every one of the 6 Years? *Anſw.* 17280 Buſhels.

Queſt. 6. If 40 Shillings is the Wages of 8 Men for 5 Days, what will be the Wages of 32 Men for 24 Days? *Anſwer*, 768 Shillings, or 38 *l*, 8 *s*.

Queſt. 7. If 14 Horſes eat 46 Buſhels of Provender in 16 Days, how many Buſhels will 24 Horſes eat in 24 Days? *Anſwer*, 120 Buſhels.

Queſt. 8. If 8 Cannons in one Day ſpend 48 Barrels of Powder, I demand how many Barrels 24 Cannons will ſpend in 22 Days at that Rate? *Anſw.* 1728 Barrels.

Queſt. 9. If in a Family conſiſting of 7 Perſons, there are drank out two Kilderkins of Beer in 12 Days, how many Kilderkins will there be drank out in 8 Days, by another Family conſiſting of 14 Perſons? *Anſwer*, 48 Gallons or 2 Kilderkins and 12 Gallons.

Queſt. 10. An Uſurer put 75 *l.* out, to receive Intereſt for the ſame, and when it had continued 9 Months, he received for Principal and Intereſt 78 *l.* 7 *s.* 6 *d.* I demand at what Rate *per Cent. per Annum*, he received Intereſt? *Anſ.* 6 *l. per Cent. per Annum.*

CHAP. XIII.

The Double Rule of Three Inverſe.

THE Double Rule of Three Inverſe is, when a Queſtion in the Double Rule of Three is reſolved by two ſingle Rules of Three, and one of thoſe Single Rules falls out to be Inverſe, or requires a fourth Number in Proportion reciprocal, for both Queſtions are never Inverſe.

2. In all Queſtions of the Double Rule of Three, as well Inverſe as Direct, you are in the Diſpoſing of the 5 given Numbers, to obſerve the 7th Rule of the 12th Chapter, and in reſolving of it by two Single Rules, obſerve to make Choice of your Numbers for the firſt and ſingle Queſtions, according to the Directious given in the 8th Rule of the ſame Chapter, and in the Example following, *viz.*

Queſt. 1. If 100 *l.* Principal in 12 Months gain 6 *l.* Intereſt, what Principal will gain 3 *l.* 7 *s.* 6 *d.* in 9 Months?

This Queſtion is an Inverſion of the firſt Queſtion of the 12th Chapter, and may ſerve for a Proof thereof.

In order to a Reſolution, I diſpoſe of the 4 given Numbers, according to the 9th Rule of the laſt Chapter; and being ſo diſpoſed, they will ſtand as followeth:

```
12   100   9     l.  s.  d.
 6               3   7   6
```

Or thus,

```
                 l.  s.  d.
 6   100         3   7   6
12               9
```

Here obſerve, That according to the 8th Rule of the 12 Chapter, the firſt Queſtion, if you take it from the 5 Numbers, as they are ordered or placed firſt, will be, if 12 Months require 100 *l.* Principal, what will 9 Months require to make the ſame Intereſt? This according to the 3d Rule of the 12th Chapter, is Inverſe, and the Anſwer will be found, by the 2d Rule of the 11th Chapter, to be 133 *l.* 6 *s.* 8 *d.* The 2d Queſtion then will be, If 6 *l.* Intereſt require 133 *l.* 6*s.* 8 *d.* Principal; how much Principal will 3 *l.* 7 *s* 6*d.* require? This is a direct Rule, and the Anſwer in a direct Proportion, 75 *l.* See the Work.

First I ſay,

```
 m     l      m.
12    100     9
      12
------------------ l.   s.  d.
9)   1200 (133     6    8
      ..
       9           l.   s,  d.
   -------    Fac. 133  6   8
      30
      27
     ----
      30
      27
     ----
       3
      20
   9) 60 (6 s.
      54
     ----
       6
     ----
   9) 72 (8 d.
      72
     ----
       0
```

Then I ſay,

l.	*l.*	*s.*	*d.*	*l.*	*s.*	*d.*
If 6	133	6	8	3	7	6
250	20			20		
1440*d.*	2666			67		
	12			12		
	5340			140		
	2666			67		
	32000			810 *d.*		
	810					

32000
256
24|0
1440|0) 2592000|0 (18000|0*d.* or 75 *l.*
. . . .   . .
144   168
1152   120
1152   20
0   0

So that by the foregoing Work I find, that if 6 *l.* Intereſt be gained by 100 *l.* in 12 Months, 3 *l.* 17 *s.* 6 *d.* will be gained by 75 *l.* in 9 Months.

But if the Reſolution has been found out by the Numbers as they are ranked in the 2d Place, then the Second Queſtion in the Single Rule would have been Inverſe, and the firſt Queſtion Direct and the Concluſion the ſame with the firſt Method, viz. 75 *l.*

Queſt. 2. If a Regiment conſiſting of 939 Soldiers, can eat up 351 Quarters of Wheat in 168 Days how many Soldiers wlll eat up 1464 Quarters in 56 Days at that Rate? *Anſwer* 71232 Soldiers.

Queſt. 3. If 12 Students in 8 Weeks ſpend 48 *l.* I demand how many Students will ſpend 288 *l.* in 18 Weeks? *Anſwer* 32 Students.

Queſt. 4. If 48*l.* ſerve 12 Students 8 Weeks, how many Weeks will 28 *l.* ſerve 4 Students? *Anſ.* 144 Weeks.

Queſt. 5. If when a Buſhel of Wheat coſt 3*s.* 4*d.* the Penny-loaf weigheth 12 Ounces, I demand the Weight of the Loaf worth 9*d.* when the Buſhel coſt 13*s.* *Anſ.* 36 Ounces.

Queſt. 6. If 48 Pioneers in 12 Days caſt a Trench 14 Yards long, how many Pioneers will caſt a Trench 168 yds long in 16 Days? *Anſ.* 252 Pioneers.

Queſt. 7. If 12 C. weight being carried 100 Miles, coſt 5*l.* 11*s.* I deſire to know how many C weight may be carried 150 Miles for 12*l.* 12*s.* at that Rate? *Anſ.* 18 C.

Queſt. 8. If when Wine is worth 30*l.* *per* Tun, 20*l.* worth is ſufficient for the Ordinary of 100 Men, how many Men will 4*l.* worth ſuffice, when it is worth 24*l.* *per* Tun? *Anſ.* 25 Men.

Queſt. 9. If 6 Men in 21 Days mow 72 Acres; in how many Days will 8 Men mow 24 Acres? *Anſ.* in 6 Days.

Queſt. 10. If when the Tun of Wine is worth 30*l.* 100 Men will be ſatisfied with 20*l.* worth I deſire to know what the Tun is worth, when 4*l.* worth will ſatisfy 25 Men at the ſame Rate? *Anſ.* 24*l.* *per* Tun.

CHAP. XIV.

The Rule of Three compoſed of five Numbers.

THE Rule of Three compoſed, is when Queſtions wherein there are 5 Numbers given to find a Sixth in Proportion thereunto, are reſolved by one Single Rule of Three compoſed of the five given Numbers.

2. When Queſtions may be performed by the Double Rule of Three Direct, and it is required to reſolve them by the Rule of Three compoſed; firſt order or rank your Numbers according to the 7th Rule of the 12th Chap. then

The Rule is,

Multiply the Terms or Numbers, that ſtand one over the other in the firſt Place, the one by the other, and make their Product the firſt Term in the Rule of Three Direct; then multiply the Terms that ſtand one over the other in the third Place, and place their Product for the

3d Term in the Rule of Three Direct, and put the middle Term of the uppermoſt for a ſecond Term; then having found a 4th Proportion Direct to theſe Three, this 4th Proportional ſo found ſhall be the Anſwer required.

So the firſt Queſtion of the 12th Chapter being propoſed, *viz.* If 100*l.* in 12 Months gain 6*l.* Intereſt, what will 75*l.* gain in 9 Months? The Numbers being marked, or placed, as is there directed and done.

Then I multiply the two firſt Terms, 100 and 12 the one by the other, and their Product is 1200 for the firſt Term; then I multiply the two laſt Terms 75 and 9 together and their Product is 675 for the firſt Term. Then I ſay, as 1200 is to 6, ſo is 75 to the Anſwer, which by the Rule of Three Direct, will be found to be 3*l.* 7*s.* 6*d.* as was before found.

3. But if the Queſtion be anſwered by the Double Rules of Three Inverſe, then, having plac'd the five given Terms as before, multiply the lowermoſt Term of the firſt Place, by the uppermoſt Term of the third Place, and put the Product for the firſt Term, then multiply the uppermoſt Term of the firſt Place, by the lowermoſt Term of the third Place, and put the Product for the third Term, and the ſecond Term of the three higheſt Numbers for the middle Term to thoſe two; then if the Inverſe Proportion is found in the uppermoſt three Numbers; the fourth Proportional Direct to theſe three ſhall be the Anſwer. So the firſt Queſtion to the 13th Chapter being ſtated, *viz.* If 100*l.* Principal in 12 Months gain 6*l.* Intereſt, what Principal will gain 3*l.* 7*s.* 6*d.* in 9 Months? State the Numbers as there directed in the firſt Order, *viz.*

m	l.	m.		
12	100	9		
l.		l.	s.	d.
6		3	7	5

Then reduce the 6*l.* and 3*l.* 7*s.* 6*d.* into Pence, and the 6*l.* is 1440*d.* and 3*l.* 7*s.* 6*d.* is 810*d.* then multiply 1440 by 9, the Product is 12960 for the firſt Term in the Rule of Three Direct, and multiply 810 by 12, the Product is 9720 for the third Term; then I ſay, as 12960 is to 130 *l.* ſo is 9720 to the Anſwer, *viz.* 75*l.* as before. But, if the Terms had been placed after the ſecond Order, *viz.*

l.	l.	l.	s.	d.
6	100	3	7	6
12		9		

Then the Inverſe Proportion is found in the loweſt Numbers, and having compoſed the Numbers for a ſingle Rule of Three, as in the ſecond Rule foregoing; then the Anſwer muſt be found by a ſingle Rule of Three Inverſe; for here it falls out to multiply 810 by 12 for the firſt Number, 1440 by 9 for the third Number; and then you muſt ſay, As 9720 is to 100*l.* ſo is 12960 to the Anſwer, which by Inverſe Proportion will be found to be 75*l.* as before.

The Queſtion in the 12th and 13th Chapters may ſerve for thy farther Experience.

CHAP. XV.

Single Fellowſhip.

FEllowſhip is that Rule of Plural Proportion, whereby we ballance Accounts depending between diverſe Perſons, having put together a general Stock, ſo that they may every Man have his proportional Part of Gain, or ſuſtain his proportional Part of Loſs.

2. The Rule of Fellowſhip is either Single, or it is Double.

3. The Single Rule is when the Stocks propounded are Single Numbers, without any Reſpect or Relation to Time, each Partner continuing his Money in Stock for the ſame me.

4. In the Single Rule of Fellowſhip, the Proportion is, as the whole Stock of all the Partners is in Proportion to the total Gain or Loſs, ſo is each Man's particular Share in the Stock, to his particular Share in the Gain or Loſs. Therefore take the Total of all the Stocks for the firſt Term in the Rule of Three, and the whole Gain or Loſs for the ſecond Term, and the particular Stock of any one of the Partners for the third Term; then multiply and divide according to the ſeventh Rule of the 9th Chapter, and the fourth proportional Number is the particular Loſs or Gain of him whoſe Stock you made your ſecond Number,

ber, wherefore repeat the Rule of Three as oſten as there are particular Stocks or Partners in the Queſtion, and the fourth Terms produced upon the ſeveral Operations are the reſpective Gain or Loſs of whoſe particular Stock given, as in the Example following.

Queſt. 1. Two Perſons, *viz.* A and B bought a Ton of Wine for 20*l.* of which A paid 12*l.* and B paid 8*l* and they gained in the Sale thereof 5*l* now I demand each Man's Share in the Gains, according to his Stock.

Firſt, I find the Sum of all their Stocks by adding them together, *viz.* 12*l* and 8*l.* which are 20*l.* then according to this Rule, I ſay firſt, if 20*l.* (the Sum of their Stocks) require 5*l.* the total Gain, how much will 12*l.* (the Stock of A) require? Multiply and divide by the 7th Rule of the 9th Chapter, and the Anſwer is 3*l.* for the Share of A in the Gains; then again I ſay, if 2 *l.* require 5*l.* what will 8*l.* require? The Anſwer is 2*l.* which is the Gain of B, ſo I conclude the Share of A to the Gain is 3*l.* and the Share of B in the Gain is 2*l.* which in all is 5*l.*

```
   12
    8
 ————
  20l.
```

```
     l.     l.     l.
  If 20     5     12
           12
        ——————
     20) 60 (3l.
         60
        ——————
          0

         l.     l.     l.
      If 20     5      8
                8
            ——————
           24) 40 (2l.
```

Queſt. 2. Three Merchants, *viz.* A, B, and C, enter upon a joint Adventure, A put into the common Stock 78*l.* B put 117*l.* and C 234*l.* and they find (when they make up their Accompts) that they have gained in all 264*l.* now I deſire to know each Man's particular Share in the Gain.

Firſt, I add their particular Stocks together, and their Sum is 429*l.* then ſay, If 426*l.* again 264*l.* what will 78*l.* gain; and what will 117*l.* and 234*l.* (the Stocks of A, B, and C) gain? Work by the three ſeveral Rules of Three, and you will find that

$$\begin{array}{r}78\\117\\234\\\hline\text{Sum } 429\end{array}$$

The Gain of $\left\{\begin{array}{c}\text{A}\\\text{B}\\\text{C}\end{array}\right\}$ is $\left\{\begin{array}{r}48\\72\\144\end{array}\right.$

Sum 264

Queſt. 3. Four Partners, *viz.* A, B, C, and D, amongſt them built a Ship, which coſt 1730*l.* of which A paid 346*l.* B 519*l.* C 692*l.* and D 173*l.* and her Freight for a certain Voyage is 370*l.* which is due to the Owners or Builders. I demand each Man's Share therein according to his Charge in building her.

Anſwer, $\begin{array}{c}\text{A}\\\text{B}\\\text{C}\\\text{D}\end{array}\left\{\begin{array}{r}74\\111\\148\\37\\\hline 370\end{array}\right.$

Queſt. 4. A, B, and C enter into Partnerſhip for a certain Time. A put into a common Stock 364*l.* B put in 482*l.* C put in 500*l.* and they gained 867*l.* Now I demand each Man's Share in the Gain, proportionable to his Stock? *Anſ.*

	l.	*s.*	*d.*
A	234	09	3 1 $\frac{156}{850}$
B	310	09	5 1 $\frac{2}{45}$
C	322	00	3 1 $\frac{9-0}{347}$
Sum	867	00	0

5. To prove the Single Rule of Fellowſhip add each Man's particular Gain or Loſs together, *(The Proof of the Rule of Single Fellowſhip)* and if the total Sum is equal to the general Gain or Loſs, then the Work is rightly performed: but otherwiſe it is erroneous. *Example,* In the firſt Queſtion of this Chapter, the Anſwer was, that the Gain of A was 3*l.* and the Gain of B 2*l.* which added together, makes 5*l.* equal to the total Gain given.

If in finding out the particular Shares of the ſeveral Partners, any thing remain after Diviſion is ended, ſuch Remainders muſt be added together, they being all Fractions of the ſame Denomination, and their Sum divided by the common Diviſor in each Queſtion, *viz.* The total Stock, and the Quotient added to the particular Gains, and then if the total Sum is equal to the total Gain, the Work is right, otherwiſe not.

As in the 4th Queſtion, the Remainder were 354, 62, and 930, which added together make 1346, which divided by 1346, the Sum of their Stock, the Quotient is 1*d.* which I add to the Pence, *&c.* and the Sum of their Share is 897*l.* equal to the total Gain, wherefore I conclude the Work is right.

CHAP. XVI.

Double Fellowſhip.

DOuble Fellowſhip, is when ſeveral Perſons enter into Partnerſhip for unequal Time; that is when every Man's particular Stock hath Relation to a particular Time.

2. In the Double Rule of Fellowſhip, multiply each particular Stock by its reſpective Time, and having added the ſeveral Products together, make their Sum the firſt Number or Term in the Rule of Three; and the total Gain or Loſs the ſecond Number, and the Product of any one's particular Stock by his Time, the third Term, and the fourth Number in Proportion thereunto is his particular Gain or Loſs, whoſe Product of Stock and Time is your third Number.

Then repeat, as in Single Fellowſhip, the Rule of Three as often as there are Products, or Partners, and the four Terms thereby invented, are the Numbers required.

Example.

Queſt. 1. *A.* and *B.* enter into Partnerſhip; *A* put in 40*l.* for 6 Months, *B* put in 75*l.* for 4 Months, and they gained 70*l.* now I demand each Man's Share in the Gain, proportional to his Stock and Time? *Anſwer A* 20*l. B* 50*l.*

To reſolve this Queſtion; I firſt multiply the Stock of A, *viz.* 40*l.* by its Time, 3 Months, and the Product is 120; then multiply the Stock of B by its Time, *viz.* 75*l.* by 4, and it produceth 300, which I add to the Product of A, his Stock and Time, and the Sum is 420. Then by the Rule of Three Direct I ſay, as 420, the Sum of the Product, is to 70, the total Gain, ſo is 120, the Product of A his Stock and Time, to 20*l.* the Share of A in the Gains. Then I ſay again, as 420 is to 75, ſo is 300 the Product of B his Stock and Time, to 50*l.* the Share of B in the Gains, and that each is to have for his Share.

	l.		l.
	40		75
	3		4
A	120	B	300
			120
		Sum	420

Queſt. 2. A, B, and C, make a Stock for 12 Months, A put in at firſt 364*l.* and 4 Months after that he put in 40*l.* B put in at firſt 408*l.* and at the End of the 7 Months he took out 86*l.* C put in at firſt 148*l.* and 3 Months after he put in 86*l.* more, and 5 Months after that he put in 100*l.* more, and at the End of 12 Months their Gain is found to be 1436*l.* I deſire to know each Man's Share in the Gains, according to his Stock and Time.

Firſt, I conſider that the whole Time of their Partnerſhip is 12 Months. Then I proceed to find out the ſeveral Products, or Stock and Time as followeth.

A had at firſt 364*l.* for 4 Months, wherefore that Product is —————— 1456

Then he put in 40*l.* which with the firſt Sum makes 404*l.* which continued the Remainder of the Time, *viz.* 8 Months, and that Product is —— 3232

The Sum of the Products of the Stock and Time of A is —————— 4688

B had 408*l.* in 7 Months, whoſe Product is —— 2856

And then took out 86*l.* therefore he left in Stock 322*l.* which continued the reſt of the Time, *viz.* 5 Months, whoſe Product is —————— 1610

The Sum of the Products of the Stock and Time of B is —————— 4466

C put in 148*l.* for 3 Months, whoſe Product being multiplied by 3, is —————— 444

Then he put in 86*l.* which, added to the firſt, *viz.* 148*l.*) makes 234*l.* which lay in Stock 5 Months, and their Product is ———————— 11

Then he put in 100*l.* more, ſo then he had in Stock 334*l.* which continued the Remainder of the Time, 4 Months, which multiplied together, produces ———————————— 1336

The Sum of the Product of the Money and of C is ———————————— 2950

B 4466

C 4688

The total Sum of all the Products ———— 12104

Then I ſay, as 12104 is to 1426, the total Gain, ſo is 4611 to the Share of A in the total Gain, *&c.* go on as in the foregoing Examples, and you will find their Shares in the Gain to be as followeth, *viz.* *Anſwer.*

The Shares of A, B, C is:

A 556 03 $6\frac{6192}{12104}$

B 520 19 $9\frac{3428}{12104}$

C 349 19 $8\frac{4716}{12104}$

1436 00 0

Queſt. 3. Three Graſiers, A, B, and C, take a Piece of Ground for 46*l.* 10*s.* in which A put 12 Oxen for 8 Months, B put in 16 Oxen for 5 Months, and C put in 18 Oxen for 4 Months; now the Queſtion is, what each Man ſhall pay of the 46*l.* 10*s.* for his Share in that Charge?

Anſwer.

		l.	*s.*
A	ſhall pay	18	00
B		15	00
C		13	10

3. The Proof of this Rule is the ſame with that of Single Fellowſhip, laid down in the 5th Rule of the 15th Chapter; and note, that,

If a Loſs be ſuſtained inſtead of a Gain among Partners, every Man's Share to be borne in the Loſs, is to be found after the ſame Method as their Gain, whether their Stocks be for equal or unequal Time.

CHAP

CHAP. XVII.

Allegation Medial.

1. THE Rule of Allegation is that Rule in Plural Proportion by which we reſolve Queſtions, wherein is a Compoſition or Mixture of diverſe Simples, as alſo it is uſeful in Compoſitions of Medicines, both for Quantity, Quality, or Price, and its Species are two, *viz.* Medial and Alternate.

2. Allegation Medial, is, when having the ſeveral Quantities and Prices of ſeveral Simples propounded, we diſcover the mean Price or Rate of any Quantity of the Mixture compounded of thoſe Simples, and the Proportion is,

As the Sum of the Simples to be mingled is to the total Value of all the Simples, ſo is any Part or Quantity of the Compoſition or Mixture to its mean Rate or Price.

Queſt. 1. A Farmer mingled 20 Buſhels of Wheat at 5*s.* *per* Buſhel, and 36 Buſhels of Rye at 3*s.* *per* Buſhel, with 40 Buſhels of Barley at 2*s.* *per* Buſhel, now I deſire to know what one Buſhel of that Mixture is worth?

To reſolve this Queſtion, add together the given Quantities, and their Value, which is 96 Buſhels, whoſe total Value is 14*l.* 8*s.* as appeareth by the Work following: For,

	Buſhels	*l.*	*s.*
	20 of Wheat, at 5*s.* *per* Buſhel, is	5	0
	36 of Rye, at 3*s.* *per* Buſhel, is	5	8
	40 of Barley, at 2*s.* *per* Buſhel, is	4	0
The Sum of their given Quantities is	96, and their Value is	14	8

Then ſay, by the Rule of Three Direct, if 96 Buſhels coſt, or is worth 14*l.* 8*s.* what is one Buſhel worth?

Buſh.	l.	s.	Buſh.
96.	14	8	1

20
96) 288 (3*s*.
288

0 *Facit* 3s. *per* Buſhel.

Queſt. 2. A Vinter mingled 15 Gallons of Canary at 8*s*. *per* Gallon, with 20 Gallons of Malaga, at 7*s*. and 6*d*. *per* Gallon, with 10 Gallons of Malaga, at 6*s*. and 8*d*. *per* Gallon, and 25 Gallons of White Wine at 4*s*. *per* Gallon. Now I demand what a Gallon of this Mixture is worth? Work as in the laſt Queſtion, and you will find the Anſwer to be 6*s*. 2*d*. 2 *qrs*. $\frac{46}{66}$.

Queſt. 3. A Grocer hath mingled 3 C. of Sugar at 56*s*. *per* C. with 3 C. of Sugar at 3*l*. 14*s*. 8*d*. *per* C. and with 6 C. at 1l. 17*s*. 4*d*. *per* C. I deſire to know the Price of a C. *wt*. of that Mixture?

Anſ. 2*l*. 13*s*. 1*d*. $\frac{7}{13}$.

3. The Proof of the Operation, is by the Price of any Quantity of the Mixture, to find out the total Value of the whole Compoſition, and if it is equal to the total Value of the ſeveral Simples, the Work is right, otherwiſe not, *(The Proof of Alligation Medial)* As in the firſt Example, the Anſwer to the Queſtion was that 3*s*. is the Price of 1 Buſhel; wherefore I ſay, by the Rule of Proportion, if 1 Buſhel be 3*s*. what is 96 Buſhels? *Anſwer* 14*l*. 18*s*. which is the total Value of the ſeveral Simples: Wherefore the Work is right.

CHAP. XVIII.

Allegation Alternate.

ALlegation Alternate is, when there are given the particular Prices of ſeveral Simples, and thereby we diſcover ſuch Quantities of thoſe Simples, as being mingled together, ſhall bear a certain Rate propounded.

2. When ſuch a Queſtion is ſtated, place the given Prices of the Simple one over the other, and the propounded Price of the Compoſition againſt them in ſuch Sort, that it may repreſent a Root, and they as ſo many Branches ſpringing from it, as in the following Example.

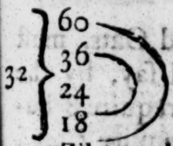
Queſt. 1. A certain Farmer is deſirous to mix 20 Buſhels of Wheat at 5*s.* or 60*d. per* Buſhel, with Rye at 3*s.* or 36*d. per* Buſhel, and with Barley at 2*s.* or 24*d. per* Buſhel, and Oats at 1*s* 6*d. per* Buſhel, and deſireth to mix ſuch a Quantity of Rye, Barley, and Oats, with the 20 Buſhels of Wheat, as that the whole Compoſition may be worth 2*s.* 8*d.* or 32*d. per* Buſhel.

The Prices of the Simples being placed according to the laſt Rule (with the Price of the Compoſition propounded as a Root to them) will ſtand as followeth.

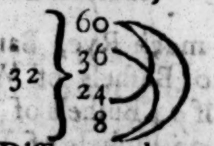
$$32\left\{\begin{array}{l}60 \text{ Pence}\\36\\24\\18\end{array}\right.$$

3. Having thus placed the given Numbers, you are to link the ſeveral Rates of the Simples one to the other, by certain Arches, in ſuch Sort; that one that is leſſer than the mean Rate, may be coupled to another that is greater than the mean Rate; ſo the Queſtion laſt propounded will ſtand.

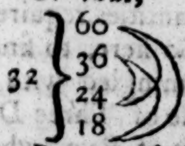
1 *Thus.*



2 *Or thus,*

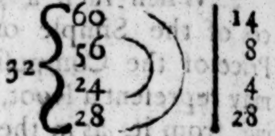


Or thus,



4. Then take the Difference between the Root and the ſeveral Branches, and place the Difference of each againſt the Number or Branch with which it is coupled or linked, and having taken all the Differences and placed them as aforeſaid, then thoſe Differences ſo placed will ſhew you the Number of each Simple to be taken to make a Compoſition to bear the mean Rate propounded.

So the Branches of the laſt Queſtion being linked together, as in the Manner, I ſay, the Difference between 32 and 60, is 28; which I put againſt 18, becauſe 60 is linked with 18, and the Difference between 32 and 36 is 4, which I put againſt 24, becauſe 36 is linked or coupled



coupled with 24, then I ſay, the Difference between 32 and 24 is 8, which I place againſt 36, for the Reaſon aforeſaid, then I ſay, the Difference between 32 and 18 is 14, which I place againſt 60; and then the Work will ſtand as you ſee in the Margin.

So I conclude that a Copoſition made of 14 Buſhels of Wheat at 9*d per* Buſhel, and 8 Buſhels of Rye at 36 *d. per* Buſhel, and 4 Buſhels of Barley at 24 *d. per* Buſhel, and 28 Buſhels of Oats, at 18 *d. per* Buſhel, will bear the mean Price of 32 *d.* or 2 *s.* 8 *d. per* Buſhel. And here obſerve, that in the Compoſition there is but 14 Buſhels of Wheat; but I would mingle 20 Buſhels, and this Kind, or rather Caſe, of Allegation Alternate, viz. when there is given a certain Quantity of one of thoſe Simples, and the Quantities of the Reſt ſought to mingle with this given Quantity, that the Whole may bear a Price propounded, is called the Allegation Partial.

And the Proportion to find out the ſeveral Quantities to be mingled with the given Quantity, is thus:

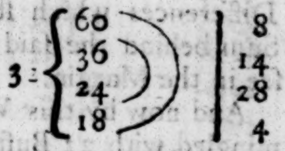
As the Difference annexed to the Branch, that is, the Value of an Integer of the given Quantity, is to the other particular Differences, ſo is the Quantity given to the ſeveral Quantities required.

So here, to find how much Rye, Barley, and Oats, muſt be mingled with the 20 Buſhels of Wheat, I ſay, by the Rule of Three Direct, if 14 Buſhels of Wheat require 8 Buſhels of Rye, what will 20 Buſhels of Wheat require? *Anſ.* $11\frac{6}{14}$ Buſhels of Rye.

Again, If 14 Buſhels of Wheat require 4 Buſhels of Barley, what will 20 Buſhels of Wheat require? *Anſ.* $5\frac{10}{14}$ Buſhels of Barley. Again I ſay, If 14 Buſhels of Wheat require 28 Buſhels of Oats, what will 20 Buſhels of Wheat require? *Anſ.* 40 Buſhels of Oats.

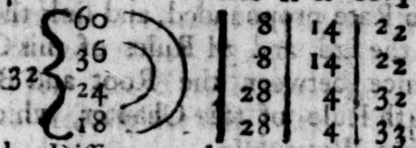
And now I ſay, that 20 Buſhels of Wheat mingled with $11\frac{6}{14}$ Buſhels of Rye, and $5\frac{15}{16}$ Buſhels of Barley, and 40 Buſhels of Oats, each bearing the Rate as aforeſaid, will make a Compoſition or Heap of Corn, that may yield 32*d. per* Buſhel?

But if the Branches had been coupled according to the ſecond Order, or Manner, the Differences would have been thus placed, *viz.* the Difference between 32 and 60 is 28, which I ſet againſt 24, becauſe 60 is linked thereto, and the Difference between 32 and 36 is 4, which I ſet againſt 18; and the Difference between 32 and 24 is 8, which I ſet againſt 60; then the Difference between 32 and 18 is 14, which I ſet againſt his Yoke-fellow 36; and then I conclude, that if you mixt 8 Buſhels of Wheat with 14 Buſhels of Rye, 28 Buſhels of Barley, and 4 Buſhels of Oats, each bearing the aforeſaid Prices, the whole Mixture may be ſold for 32 *d. per* Buſhel as by the Work in the Margin.



You ſee by this Work we have found how many Buſhels of Rye, Barley and Oats, ought to be mixed with 8 Buſhels of Wheat, and to find out how many of each ought to be mixed with 20 Buſhels of Wheat, I ſay, as 1 is to 14, ſo is 20 to 35 Buſhels of Rye. As 1 is to 28, ſo is 20 to 70 Buſhels of Barley. As 8 is to 4, ſo is 20 to 10 Buſhels of Oats; whereby I conclude, that if to 20 Buſhels of Wheat I put 35 Buſhels of Rye, 70 Buſhels of Barley, and 10 Buſhels of Oats, bearing each the aforeſaid Price *per* Buſhel, that then a Buſhel of this Mixture will be worth 32 *d.* or 2 *s.* 8 *d.*

And if the Branches had been linked, as you ſee in the 3d Place, where each Branch, bigger than the Root, is link'd to two that are leſſer than the Root, then in this Caſe you muſt have placed the ſeveral Difference between the Root and Branches againſt thoſe two with which each is coupled at firſt, the Difference between 32 and 60 is 28, which I ſet againſt 24 and 18, becauſe it is coupled with them both, then the Difference between 32 and 36 is 4, which I ſet likewiſe againſt 3, and 18, becauſe 36 is linked to them both, then the Difference between 32 and 24 is 8, which I put againſt 60 and 36, becauſe 24 is linked to them



them both, then the Difference between 32 and 18 is 14, which I put againſt 60 and 36, the Yoke-fellows of 18.

Laſtly, I draw a Line behind the Difference, and add the Differences which ſtand againſt each Branch, and put the Sum behind the ſaid Line againſt its proper Branch, as you ſee in the Margin.

And now by this Work, I find that 22 Buſhels of Wheat mingled with 22 Buſhels of Rye, and 32 Buſhels of Barley, and 22 Buſhels of Oats, each bearing the ſaid Price, will make a Mixture bearing the mean Rate of 32*d. per* Buſhel.

And to find how much of each of the reſt muſt be mingled with 20 Buſhels of Wheat; I ſay,

As 22 is to 32, ſo is 20 to 29 Buſhels of Rye. As 22 is to 32, ſo is 20 to 19 $\frac{1}{34}$ Buſhels of Oats.

Whereby you ſee the Queſtions of Allegation Alternate, will admit of more true Anſwers than one; for we have found 3 ſeveral Anſwers to this firſt Queſtion.

The Proof of Alternate *Partial.*

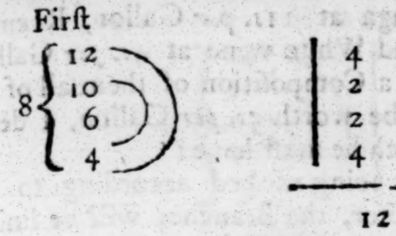
Queſtions of Allegation Partial are proved the ſame Way with Queſtions in Allegation Medial, which you may ſee in the third Rule of the 17th Chapter.

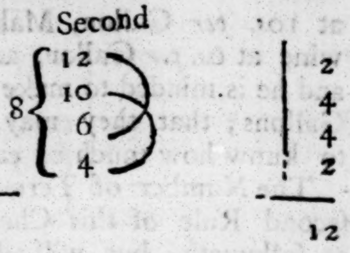
Queſt. 3. A Grocer hath 4 Sorts of Sugar, *viz.* of 12*d. per lb.* of 10*d. per lb.* of 6*d. per lb.* and of 4*d. per lb.* and would have a Compoſition worth 8*d per lb.* the whole Quantity thereof ſhould contain 144*lb.* made of theſe four Sorts, I demand how much of each he muſt take.

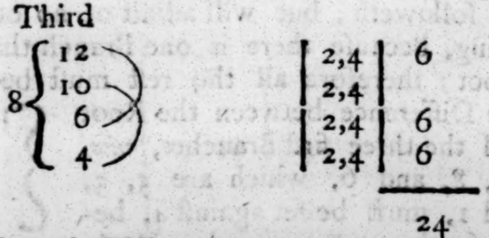
Queſtions of this Nature are reſolved by that Part of Allegation Alternate, called by Arithmeticians Allegation Total, *viz.* where there is given the Sum and Price of ſeveral Simples, to find out how much of each Simple ought to be taken to make the ſaid Sum or Quantity, ſo that it may bear a certain Rate propounded.

To reſolve this Queſtion, I place the ſeveral Pieces of the Simples and mean Rate propounded, and link them together, as is directed in the 2d and 3d Rules of this Chapter, and place the Difference between the Root and Branches, according to the 4th Rule of this Chapter, which will then ſtand one of theſe 3 Ways, *viz.*

First







5. Then add the ſeveral Differences together, which I have done, and the Sums of the firſt and ſecond Order are 12*l.* and of the 3d, 24*l.* as you ſee above. But it required that there ſhould be 144*l.* of the Compoſition, therefore to find the Quantity of each Simple to make the whole Compoſition 144*l.* Obſerve this general Rule, *viz.*

As the Sum of the Differences is to the ſeveral Differences, ſo is the Total Quantity of the Compoſition to the Quantity of each Simple.

So to find how much of each Sort of Sugar I ought to take to make 144*l.* at 8*d. per lb.*

As 12 is to 4, ſo is 144 to 48*l.* at 12*d. per lb.*
As 12 is to 2, ſo is 144 to 24*l.* at 10*d. per lb.*
As 12 is to 2, ſo is 144 to 24*l.* at 6*d. per lb.*
As 12 is to 4, ſo is 144 to 48*l.* at 8*d. per lb.*

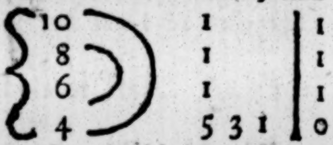
Whereby I find that 48*l.* at 12*d. per lb.* and 246*l.* at 10*d. per lb.* and 24 *lb.* at 6*d. per lb.* and 48*l.* at 4*d. per lb.* will make a Compoſition of Sugar containing 144 *lb.* worth at 8*d. per lb.*

But as the Branches are linked in the 2d Order, the Anſwer will be 24 *lb.* at 12*d. per lb.* and 48*lb.* at 10*d. per lb.* and 48*lb.* at 6*d. per lb.* and 24 *lb.* at 4*d. per lb.* to make the ſaid Quantity, and to bear the ſaid Price.

And if you had worked as the Branches are linked from the third Order, then you would have found the Quantity of 36 *lb.* of each.

Queſt. 3. A Vinter hath four Sorts of Wine, *viz.* Canary at 10*s. per* Gallon, Malaga at 11*s. per* Gallon, Rheniſh-wine at 6*s. per* Gallon, and White wine at 4*s. per* Gallon, and he is minded to make a Compoſition of them all of 60 Gallons; that they may be worth 5*s. per* Gallon, I deſire to know how much of each he muſt have?

The Number of Terms being ranked according to the ſecond Rule of this Chapter, the Branches will be linked as followeth; but will admit of no other manner of coupling, becauſe there is one Branch that is leſſer than the Root; therefore all the reſt muſt be linked unto it; and the Difference between the Root and the three firſt Branches, *viz.* 10, 8, and 6, which are 5, 3, and 1, muſt be ſet againſt 4, becauſe they are coupled with it, and the Difference between the Roots, *viz.* 5 and 4 which is 1, muſt be ſet againſt the 3 other, becauſe it is linked to them all; ſo I find that one Gallon of Canary, 1 Gallon of Malaga, 1 Gallon of Rheniſh-wine, and 9 Gallons of White-wine, prized as above, being mingled together will be worth 5*s. per* Gallon, the Sum being 11 Gallons; but there muſt be 60 Gallons; whereof I ſay,

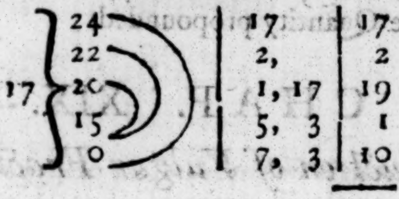


As 12 is to 1, ſo is 60 to 5 Gallons of Canary.
As 12 is to 1, ſo is 60 to 5 Gallons of Malaga.
As 12 is to 1, ſo is 60 to 5 Gallons of Rheniſh.
As 12 is to 9, ſo is 60 to 5 Gallons of White-wine.

So that 5 Gallons of Canary, 5 Gallons of Malaga, 5 Gallons of Rheniſh, and 45 of White-wine, mingled together, will be in all 60 Gallons worth 5*s. per* Gallon, which was required.

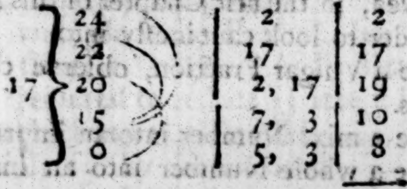
Queſt. 4. A Goldſmith hath Gold of four ſeveral Sorts of Fineneſs, *viz,* of 24 Caracts fine, and of 22 Caracts fine, of 20 Caracts fine, and of 15 Caracts fine, (*Read Ch.* 3. *Def.* 2. *of his Book.*) And he would mingle ſo much of each with Allay, that the whole Maſs of 28 Ounces of Gold ſo mingled, may bear 17 Caracts fine, I demand how much of each he muſt take? The 2d and 3d Rules of this Chapter being obſerved; for inſtead of the Allay I put 0 becauſe it bears no Fineneſs, but it makes a Branch in the Operation, the Terms may be allegated, and the Differences added by any of theſe 4 Ways following, *viz.*

First thus:



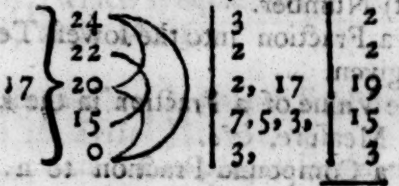
	24	17	17
	22	2,	2
17	20	1, 17	19
	15	5, 3	1
	0	7, 3,	10
			49

Secondly thus:



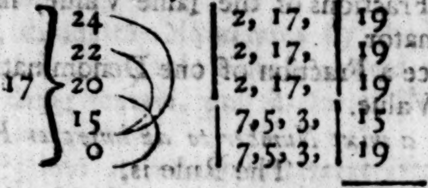
	24	2	2
	22	17	17
17	20	2, 17	19
	15	7, 3	10
	0	5, 3	8
			Sum 56

Thirdly thus:



	24	3	2
	22	2	2
17	20	2, 17	19
	15	7, 5, 3,	15
	0	3,	3
			Sum 41

Fourthly thus:



	24	2, 17,	19
	22	2, 17,	19
17	20	2, 17,	19
	15	7, 5, 3,	15
	0	7, 5, 3,	19
			Sum 91

More Ways may be given for the alligating or linking of the Terms in this Queſtion, but theſe, if well practiſed, are ſufficient for underſtanding the Rules of Alligation.

In Queſtions of Alligation to al, the Anſwer is given true, when the Sum of each of the Quantities of Simples found, (*The Proof of Alternation Total*) agrees with the Sum or Quantity propounded; as in the laſt Queſtion, the Anſwer was 8 *oz.* 10 *p. wt.* of 24 Caracts fine, 10 *oz.* of 22 Caracts fine, 9 *oz.* 10 *p. wt.* of 20 Caracts fine, 4 of

25 Caracts fine, and 5 *oz.* of Alloy, which added together, make 28 *oz.* the Quantity propounded.

CHAP. XIX.

Reduction of Vulgar Fractions.

1. WHAT a Vulgar Fraction is, hath been already ſhewed, in the firſt Chapter of this Book, to which I refer the Reader to look cautiouſly into.

2. To reduce a Vulgar Fraction, obſerve carefully theſe 8 following Rules.

1. To reduce a mixt Number into an improper Fraction.

2. To reduce a whole Number into an improper Fraction.

3. To reduce an improper Fraction into its equivalent whole, (or mixt) Number.

4. To reduce a Fraction into the loweſt Terms equivalent to the Fraction given.

5. To find the Value of a Fraction in the known Parts of Coin, Weight, Meaſure, &c.

6. To reduce a Compound Fraction to a ſimple one of the ſame Value.

7. To reduce diverſe Fractions having an unequal Denomination, to Fractions of the ſame Value, having an unequal Denominator.

8. To reduce a Fraction of one Denomination to another of the ſame Value.

I. *To reduce a mixt Number to an improper Fraction.*

The Rule is,

Multiply the Integer Part (or whole Number) by the Denominator of the Fraction (*Vid. Chap.* 1. *Defin.* 31,) and to the Product add the Numerator, and that Sum place over the Denominator for a new Numerator, ſo this new Fraction ſhall be equal to the mixt Number given. As for Example.

1. Reduce $18\frac{3}{7}$ into an improper Fraction, multiply the whole Number 18 by 7 the Denominator, and to the Product add the Numerator 3, the Sum is 129, which put over the Denominator 7, and it makes $\frac{129}{7}$ for the Anſwer as followeth.

$18\frac{3}{7}$
7

Facit 129

7

2. Reduce $113\frac{5}{21}$ to an improper Fraction. *Facit* $\frac{2373}{21}$

3. Reduce $50\frac{12}{31}$ to an improper Fraction. *Facit* $\frac{1562}{31}$

II. *To reduce a whole Number into an improper Fraction.*

The Rule is, multiply the given Nnmber by the intended Denominator, and place the Product for the Numerator over it. (*Vid. Chap.* 1. *Defin.*) As for Example:

1. Let it be required to reduce 15 into a Fraction, whoſe Denominator ſhall be 12. To effect which, I multiply 15 by the intended Denominator (12) the Product is 180 which I place over 12 as a Numerator and it makes $\frac{180}{12}$, which is equal to 15 *Facit* $\frac{180}{12}$ as was required, as *per* Margin.

15
12

30
15

180

2. Reduce 36 into an improper Fraction, whoſe Denominator ſhall be 26. *Facit* $\frac{936}{26}$.

3. Reduce 145 into an improper Fraction, whoſe Denominator ſhall be 16. *Facit* $\frac{2100}{16}$.

III. *To reduce an improper Fraction into an equivalent whole or mixt Number.*

The Rule is, divide the Numerator by the Denominator, and the Quotient is the whole Number equal to the Fraction, and if any thing remain, put it for a Numerator over the Diviſor. Example.

1. Reduce $\frac{436}{8}$ into its equivalent mixt Number, divide the Numerator 436 by the Denominator 8, and the Quotient is 54, and 4 remains, wnich put for a Numerator over the Diviſor 8, the Anſwer is $5\frac{4}{8}$, as followeth.

8) 436 (54
40

36 *Fa.* $54\frac{4}{8}$,
32

4

2. Reduce $\frac{3466}{15}$ to a mixt Number. *Facit* 231 $\frac{1}{15}$.
3. Reduce $\frac{15804}{188}$ to a mixt Number. *Facit* 114 $\frac{72}{138}$.

IV. *To reduce a Fraction into its loweſt Terms equivalent to the Practice given.*

The Rule is, 1. If the Numerator and Denominator are even Numbers, take half the one and half of the other, as often as may, be and when either of them falls out to be an odd Number, then divide them by any Number that you can diſcover, will divide both Numerator and Denominator without any Remainder; and when you have thus proceeded, as low as you can reduce them, then this new Fraction ſo found out, ſhall be the Fraction you deſire, and will be in Value to the given Fraction.

Example 1. Let it be required to reduce $\frac{192}{336}$ into its loweſt Terms. Firſt, I take the Half of the Numerator 192, and it is 96, then half of the Denominators, and it is 168, ſo that it is brought to $\frac{96}{168}$, and next to $\frac{48}{84}$, and by halfing ſtill, to $\frac{24}{48}$, and their half is $\frac{12}{24}$, and now I can no longer half it, becauſe 21 is an odd Number, wherefore I try to divide them by 3, 4, 5, 6, &c. and I find 3 divides them both without any Remainder, and brings them $\frac{7}{4}$ as per Margin.

192	96	48	24	12	7
336	168	84	48	24	4

So I conclude $\frac{7}{4}$ thus found to be equal in Value to the given Fraction $\frac{163}{136}$.

2. What is $\frac{8626}{144}$ in its loweſt Terms? *Anſ.* $\frac{3}{8}$.

3. What is $\frac{3628}{2876}$ in its loweſt Terms? *Anſ.* $\frac{11}{12}$.

The beſt Way to reduce a Fraction into its loweſt Terms, is, by finding a common Meaſure, viz. the greateſt Number that will divide the Numerator and Denominator without any Remainder, and by that Means reduce a Fraction to its loweſt Terms at the firſt Work; and to find out this common Meaſure, divide the Denominator by the Numerator, and if any thing remain divide your laſt Diviſor by it; do ſo until you find nothing remaining: then this laſt Diviſor ſhall be your greateſt common Meaſurer, which will divide both Numerator and Denominator, and reduce them both into their loweſt Terms at one Work.

Exam. 4. Reduce $\frac{228}{304}$ into its loweſt Terms by a common Meaſure; to effect which, I divide the Denominator 304 by the Numerator 228, and there remains 76, then I divide 228 (the firſt Diviſor) by 76 (the Remainder) and it quotes 3, and nothing remains; wherefore the laſt Diviſor 76 is the common Meaſure; by which I divide the Numerator of the given Fraction, viz. 228, it quotes 3 for a new Numerator, then I divide the Denomina or 304 by 76, and it quotes 4 for a new Denominator, ſo that now I have found 34 equal to $\frac{228}{503}$.

5. Reduce $\frac{6008}{8064}$ into its loweſt Terms by a common Meaſure. *Fac.* $\frac{9}{12}$.

6. Reduce $\frac{3681}{20382}$ into its loweſt Terms by a common Meaſurer. *Fac.* $\frac{13}{80}$.

A Compendium.

Note, That if the Numerator or Denominator of a Fraction, and each with a Cypher or Cyphers, then cut off as many Cyphers from the one as from the other, and the remaining Figures will be a Fraction of the ſame Value, viz. $\frac{3400}{7100}$ will be found to be reduced to $\frac{34}{71}$, by cutting off the two Cyphers from the Numerator and Denominator, with a Daſh of the Pen thus. $\frac{3|400}{7|100}$, and $\frac{460}{760}$ will be $\frac{46}{76}$, thus, $\frac{46|0}{70|0}$, &c.

V. *To find the Value of a Fraction in the known Parts of Coin, Weights, &c.*

The Rule is, Multiply the Numerator by the Parts of the next inferoir Denomination that are equal to an Unit of the ſame Denomination with the Fraction; then divide that Product by the Denominator, and the Quote gives you its Value in the ſame Parts you multiplied by, and if any Thing remain, multiply it by the Parts of the next inferior Denomination, and divide as before; do ſo till you can bring it no lower, and the ſeveral Quotients, will give you the Value of the Fraction as was required; and if any at laſt remain, place it for a Numerator over the former Denominator. Some few Examples will make the Rule plain.

1. What is the value of $\frac{27}{29}$. Sterling? To anſwer this Queſtion I multiply the Numerator 27 by 20, the Shillings in a Pound, the Product is 540, which I divide by 29, the Denominator, and the Quotient is 18*s.* and there remains 18, which I multiply by 12 Pence, and the Product (216) I divide by the Denominator 29, the Quotient is 7*d.* and 13 remains, which I multiply by 4 Farthings, the Product is 52, which I ſtill divide by 29, the Quotient is 1qr. and there remaineth 23, which I put for a Numerator over the Denominator 29, to find the Value of $\frac{27}{29}$*l.* to be 12*s.* 7*d.* 1*qr.* $\frac{27}{29}$, as by the Work in the Margin, and after the ſame manner are the Values of the Fractions in the ſeveral Examples following found out.

$\frac{27}{29}$
27
Multiply 20
———
29) 540 18s. 7d. 1$\frac{23}{29}$
29
———
250
232
———
(18)
(12)
———
36
18
———
29) 216 7d.
203
———
Rem. (13)
Mult. 4
——— qr.
29) 52 (1$\frac{23}{29}$
29
———
Rem. (23)

s. d. qr.
Facit 18. 7 1$\frac{23}{29}$

And ſo likewiſe you may find the Value of any Fraction, either in Weight or Time, &c.

VI. *To reduce a Compound Fraction to a Simple of the ſame Value.*

What a compound Fraction is, hath been ſhewn in Chapter 1. Definition 24, and to reduce it to a Simple Fraction of the ſame Value.

The Rule is, multiply the Numerator continually, and place the laſt Product for a new Numerator, then multiply the Denominations continually, and place the laſt Product for a new Denominator. So this ſingle Fraction ſhall be equal to the Compound Fraction. *Example.*

1. Reduce $\frac{2}{3}$ of $\frac{3}{5}$ to a Simple Fraction.

Multiply the Numerators 2, 3, and 5 together, they make 33 for a new Numerator; then I multiply the Denominators 3, 5, and 8 together, and their Product is 120 for a Denominator, ſo the Simple Fraction is $\frac{30}{129}$, and cutting off the Cyphers, it is $\frac{3}{12}$, equal to $\frac{1}{4}$ by the 4th Rule following.

$$\begin{array}{r} 3\\ 5\\ \hline 15\\ 8\\ \hline 120 \end{array} \qquad\qquad \begin{array}{r} 3\\ 2\\ \hline 6\\ 5\\ \hline 30 \end{array}$$

Facit $\frac{34}{140}$, or $\frac{3}{12}$, or $\frac{1}{4}$.

2. What is $\frac{7}{10}$ of $\frac{5}{9}$ of $\frac{4}{7}$ of $\frac{11}{24}$? *Anſ.* $\frac{1340}{560}$, or $\frac{140}{75}$, or $\frac{2}{63}$, in its loweſt Terms.

3. What is $\frac{11}{12}$ of $\frac{13}{14}$ of $\frac{21}{24}$: *Anſ.* $\frac{3003}{4082}$.

By this you may know how to find the Value of a Compound Fraction, *viz.* Firſt, reduce it into a Simple one, and then find out his Value by the 5th Rule foregoing.

Example 4. What is the Value of $\frac{3}{4}$ of $\frac{5}{6}$ of $\frac{7}{8}$ of a Pound? *Anſ.* 10*s.* 11*d.* 1*qr.*

VII. *To reduce Fractions of unequal Denominations to Fractions of the ſame Value, having unequal Denominators.*

The Rule is, multiply all the Denominators together, and the Product ſhall be the common Denominator. Then multiply each Numerator into all the Denominations except its own, and the laſt Product put for a Numerator over the Denominator, found out as before: So this new Fraction is equal to that Fraction whoſe Numerator you multiply into the ſaid Denominator. Do ſo by all the Numerators given, and you have your Deſire.

Example 1. Reduce $\frac{3}{7}$, $\frac{4}{5}$, $\frac{5}{6}$, and $\frac{4}{8}$ to a common Denominator. Multiply the Denominators 4, 5, 6, and 8 together continually, and put the Product 960 for the common Denominator; then multiply the Numerator 3 into the Denominators 5, 6, and 8, and the Product is 720, which is a Numerator 960, found as before, ſo $\frac{720}{960}$ is equal to the firſt Fraction $\frac{3}{4}$; then I proceed to find a new Numerator to the new Numerator to the 2d Fraction, viz $\frac{5}{4}$, and I multiply 4 (into all the Denominators) except its own, viz into 4, 6 and 8, which produceth $\frac{760}{260}$ equal to $\frac{4}{5}$, then multiply the Numerator 5 into the Denominators, 4, 6 and 8, the Product is $\frac{800}{960}$ equal to $\frac{5}{6}$. Then multiply the Numerator 7 into the Denominators 4, 5 and 6, the Production is $\frac{840}{960}$, equal to $\frac{7}{8}$, and the Work is done; ſo that for $\frac{3\,4\,5}{5\,6}$ and $\frac{7}{8}$ I have $\frac{730}{960}$, $\frac{768}{960}$, $\frac{800}{900}$, and $\frac{840}{960}$.

1. Reduce $\frac{11}{12}$, $\frac{14}{25}$, and $\frac{19}{21}$ into acommon Denominator. *Facit* $\frac{3311}{5796}$, $\frac{3725}{6706}$, and $\frac{5244}{5775}$.

VIII. *To reduce a Fraction of one Denomination to another.*

1. This is either Aſcending or Deſcending. Aſcending is when a Fraction of a ſmaller is brought to a greater Denomination; Deſcending is when a Fraction of a greater Denomination is brought lower.

2. When a Fraction is to be brought from a leſſer to a greater Denomination, then make of it a compound Fraction, by comparing it with the intermediate Denominations between it, and that you would have it reduced to, then (by the 6th Rule foregoing) reduce your compound to a ſingle Fraction, and the Work is done. Example.

Queſt 1. It is required to know what Part of a Pound Sterling $\frac{5}{7}$ of a Penny is?

To reſolve this, I conſider that 1 *d.* is $\frac{1}{12}$ of a Shilling, and a Shilling is $\frac{1}{20}$ of a Pound; wherefore, $\frac{5}{7}$ *d.* is $\frac{5}{7}$ of $\frac{1}{12}$ of $\frac{1}{20}$ of a Pound, which by the ſaid 6th Rule I find to be $\frac{5}{1680}$ of a Pound Sterling of *Engliſh* Money.

Queſt. 2. What Part of a Pound Troy weight is $\frac{4}{5}$ of a Penny-weight? *Anſ.* $\frac{1}{5}$ of $\frac{1}{20}$ of $\frac{1}{12}$, equal to 1 $\frac{4}{100}$ Troy.

3. When a Fraction is to be brought from a greater to a leſſer Denomination, then multiply the Numerator by the Parts contained in the ſeveral Denominations betwixt it, and the Parts you would reduce it to; then Place the laſt Product over the Denominator of the given Fraction. Example,

Queſt. 4. I would reduce $\frac{3}{5}$ *l.* to the Fraction of 1 *d.* to do which, I multiply the Numerator 3 by 20 and 12, the Product is 720, which I put over the Denominator 5, it makes $\frac{720}{5}$ of 1 *d.* equal to $\frac{3}{5}$ *l.*

Queſt. 5. What Part of an Ounce Troy is $\frac{1}{16}$ *lb*? *Anſ.* $\frac{12}{15}$ or $\frac{3}{4}$ oz.

CHAP. XX.

Addition of Vulgar Fractions.

1. IF your Fractions to be added have a common Denominator, then add all the Numerators together, and place their Sum for a Numerator to the common Denominator, which new Fraction is the Sum of all the given Fractions; and if it be improper, reduce it to a whole or mixt Number, by the 3d Rule in the 29th Chapter.

Queſt. 1. What is the Sum of $\frac{7}{24}$, $\frac{9}{24}$, $\frac{16}{24}$, and $\frac{14}{24}$?

The Denominators are equal, viz. every one is 24, wherefore add the Numerators together, viz. 7, 9, 16, and 14, their Sum is 46, which put over the Denominator 24, it makes $\frac{46}{24}$ the Sum of the given Fractions, which will be reduced to the mixt Numbers $1\frac{22}{24}$, $1\frac{11}{12}$.

2. But if the Fractions to be added have unequal Denominators, then reduce them to a common Denominator by the 7th Rule of Chapter 19, and then add the Numerator together, and put the Sum over the common Denominator, &c. as before in the laſt Example.

Queſt 2. What is the Sum of $\frac{3}{5}$, $\frac{7}{8}$, $\frac{6}{13}$, $\frac{11}{12}$?

The Fractions reduced to a common Denominator are $\frac{3744}{6240}$, $\frac{5460}{6240}$, $\frac{2880}{6240}$, and $\frac{5720}{6240}$, the Sum of their Numerators is 17084, which put over the Common Denominator makes $\frac{3744}{6240}$, or $2\frac{1531}{1560}$.

Anſ. $1\frac{29595}{9151}$.

3. If you are to add mixt Numbers together, then add the Fractional Parts as before, and if their Sum be an improper Fraction, reduce it to a mixt Number, and add its Integral Part to the Integral Parts of the given mixut Numbers, and the Work is done.

Queſt. 4. What is the Sum of $13\frac{3}{4}$, and $24\frac{5}{8}$?

Firſt add the Fractions $\frac{8}{4}$ and $\frac{5}{8}$, the Sum is $1\frac{2}{18}$, then add the Integers 1, 13, and 24, their Sum is 38, and put after it the Fraction $\frac{12}{32}$, it is $38\frac{12}{32}$, or it is $38\frac{3}{4}$?

Facit. $126\frac{45}{56}$.

4. If any of the Fractions to be added is a Compound Fraction, it muſt firſt be reduced to a Single Fraction by

the 9th Rule of Chap. 19, and then add it to the reſt, according to the ſecond Rule of this Chapter. *Example:*

Queſt. 6. What is the Sum of $\frac{3}{4}$, $\frac{5}{6}$, and $\frac{7}{8}$ of $\frac{3}{4}$ of $\frac{5}{6}$?

Reduce $\frac{7}{8}$ of $\frac{3}{4}$ of $\frac{5}{6}$ into a Simple Fraction, and it is $\frac{105}{193}$, which reduce with the other two, and added, are $2\frac{25}{102}$.

Queſt. 7. What is the Sum of $\frac{11}{12}$ and $\frac{1}{4}$ of $\frac{4}{5}$ of $\frac{5}{6}$?

Anſ. $1\frac{5}{6}$.

5. If the Fractions to be added are not of one Denomination, they muſt be ſo reduced, and then proceed as before.

Queſt. 8. What is the Sum of $\frac{3}{4}$*l.* and $\frac{5}{6}$*s.*

Of the given Fraction here, one is of a Pound, and the other the Fraction of a Shilling, and before you can add them together, you muſt reduce $\frac{5}{6}$*s.* to the Fraction of a Pound, as the other is, by the Rule of Chap. 19. and it makes $\frac{5}{120}$*l.* the $\frac{3}{4}$ and $\frac{5}{120}$*l.* will be found to be $\frac{380}{480}$*l.* or $\frac{38}{48}$*l.* by the 7th Rule of Chap. 19. and in its loweſt Terms, $\frac{19}{24}$*l.* by the fourth Rule of Chap. 19.

It would have been the ſame, if by the latter Part of the 8th Rule of Chap. 19, you have reduced $\frac{3}{4}$*l.* to the Fraction of a Shilling, which you would have found to have been $\frac{60}{4}$*s.* which added to $\frac{5}{6}$*s.* by the ſaid 17th Rule of the laſt Chapter, the Sum is 16*s.* $\frac{50}{24}$, which is equal to the Sum found as before, *viz.* $\frac{20}{24}$*l.* for by the 5th Rule of Chapter 12, the Value of $\frac{10}{24}$*l.* will be found to be 15*s.* 10*d.* and ſo will 15*s.* $\frac{20}{24}$ be found to be juſt as much.

Queſt. 9. What is the Sum of $\frac{3}{4}$*l.* $\frac{3}{4}$*s.* and $\frac{5}{4}$*d*

Anſ. $\frac{375600}{480000}$ or $\frac{3756}{4800}$ or in its loweſt Terms $\frac{213}{400}$

CHAP. XXI.

Subtraction of Vulgar Fractions.

1. THE Rules in Addition for reducing the given Fractions to one Denomination, are here to be obſerved, for before Subtraction can be made, the Fractions muſt be reduced to a common Denominator, then ſubſtract one Numerator for the other, and place the Remainder over a common Denominator; which Fraction ſhall be the Ex-

Exceſs or Difference between the given Fractions. Example:

Queſt. 1. What is the Difference between $\frac{3}{4}$ and $\frac{5}{7}$. The given Fractions are reduced to $\frac{21}{28}$, then ſubſtract the Numerator 20 from the Numerator 21, and there remains, 1, which being put over the Denominator 28, makes $\frac{1}{28}$ for the Anſwer or Difference between $\frac{3}{4}$ and $\frac{5}{8}$.

Queſt. 2. What is the Difference between $\frac{3}{6}$ and $\frac{3}{4}$ of $\frac{5}{8}$.

Reduce the Compound Fraction $\frac{3}{4}$ of $\frac{5}{8}$ to a ſimple Fraction, then proceed as before and the Anſwer is $\frac{70}{192}$ equal to $\frac{35}{96}$.

2. When a Fraction is given to be ſubſtracted from a whole Number, ſubſtract the Numerator from the Denominator, and put the Remainder for a Numerator to the given Denominator, and ſubſtract an Unit (for that you borrowed) from the whole Number, and the Remainder place before the Fraction found, as before, which mixed Number is the Remainder or Difference ſought. Example:

Queſt. 3 Subſtract $\frac{7}{10}$ from 48?

Anſwer. 47 $\frac{3}{10}$; for if you ſubſtract 7 (the Numerator) from 10 (the Denominator) there remains 3, which put over 10 is $\frac{3}{10}$, and it makes 47 $\frac{3}{10}$ for the Exceſs.

Queſt. 4. Subſtract $\frac{13}{18}$ from 57, remains 56 $\frac{5}{18}$.

3. If it be required to ſubſtract a Fraction from a mixt Number, or one mixt Number from another, reduce the Fraction to a common Denominator, and if the Fraction to be ſubſtracted be leſſer than the other, then ſubtract the leſſer Numerator from the greater, and that is a Numerator for the common Denominator; then ſubſtract the leſſer integral Part from the greater, and the Remainder with the remaining Fractions thereunto annexed, is the Difference required between the two given mixt Numbers. Example:

Queſt. 5. Subſtract $26\frac{3}{7}$ from $54\frac{5}{6}$.

Firſt, Subſtract $\frac{3}{7}$, *viz.* $\frac{18}{42}$ from $\frac{5}{6}$, *viz.* $\frac{35}{42}$, the Remainder is $\frac{17}{42}$, then 26 from 64 remaineth 28, to which annex $\frac{17}{42}$ it makes $28\frac{17}{42}$ for the Anſwer.

4. But if the Fraction to be ſubſtracted is greater than the Fraction from whence you ſubſtract, then having firſt reduced the Fractions to a common Denominator, take the Numerator of the greateſt Fraction out of the Denominato

and add the Remainder to the Numerator of the leſſer Fraction, and their Sum is a new Numerator to the common Denominator, which Fraction Note, then (for the one you borrowed) add one to the integral Part to be ſubtracted, and ſubſtract it from the greater Number, and to the Remainder annex the Fraction you noted before, ſo this new mixt Number ſhall be the Difference ſought Example:

Queſt. 6. Subſtract $14\frac{3}{4}$ from $29\frac{4}{7}$?

The Fractions reduced are, viz. $\frac{3}{4}$, equal to $\frac{21}{28}$, and $\frac{4}{7}$ equal to $\frac{16}{28}$, now I ſhould ſubſtract $\frac{21}{28}$, from $\frac{16}{48}$, but I cannot therefore ſubtract 21 from 28, reſt 7, which added to 16 (the leſſer Numerator) make 23 for a Numerator to 28, viz. $\frac{23}{28}$; then I come to the integral Parts 14 and 29, and ſay, 1 that I borrowed and 14 is 15, which taken from 29, there reſts 14, to which annexing $\frac{23}{28}$, it is $14\frac{23}{28}$, for the Remainder or Difference between $14\frac{3}{4}$ and $29\frac{4}{7}$.

Queſt. 7. Subſtract $36\frac{9}{60}$ from $74\frac{2}{9}$? *Facit* $37\frac{49}{90}$.

CHAP. XXII.

Multiplication of Vulgar Fractions.

1. If the Multiplicand and Multiplier are ſimple Fractions, then multiply the Numerators together for a new Numerator, and the Numerators for a new Denominator, and the new Fraction is the Product required.

Queſt. 1. What is the Product of $\frac{5}{7}$ by $\frac{9}{11}$? *Facit* $\frac{45}{77}$; for the Numerators 5 and 9 being multiplied, make 45, and the Denominators 7 and 11 being multiplied, make 77.

Queſt. 2. What is the Product of $\frac{8}{25}$ by $\frac{2}{37}$? *Facit* $\frac{148}{952}$.

2. If the Fractions to be multiplied be mixt Numbers reduce them to improper Fractions by the firſt Rule of the 9th Chapter, then proceed as before.

Queſt. 3. What is the Product of $28\frac{3}{5}$ by $13\frac{5}{7}$?

The given mixt Numbers being reduced to improper Fractions are $48\frac{3}{5}$ equal to $\frac{243}{9}$, and $13\frac{5}{6}$ equal to $\frac{83}{6}$, now $\frac{243}{9}$ multiplied by $\frac{83}{6}$ according to the firſt Rule of this Chapter produceth $\frac{20109}{30}$ or $672\frac{12}{10}$.

Queſt. 4. What is the Product of $430\frac{6}{10}$ by $18\frac{2}{7}$? *Facit* $\frac{38474}{70}$ or $7225\frac{20}{70}$.

3. If a Compound Fraction is to be multiplied by a Sim-

ple Fraction, firſt reduce the Compound Fraction into a ſimple Fraction, then multiply the one by the other, as is taught above.

Queſt. 5. What is the Product of $\frac{16}{21}$ by $\frac{3}{4}$ of $\frac{5}{7}$ of $\frac{4}{5}$.

The Compound Fraction $\frac{3}{4}$ of $\frac{5}{7}$ of $\frac{4}{5}$ is reduced $\frac{90}{140}$, or $\frac{3}{7}$ which multiplied by $\frac{16}{21}$, produces $\frac{41}{187}$, which in its loweſt Terms is $\frac{59}{39}$, for the Anſwer.

And if the Multiplicand and Multiplier are both Compound Fractions, reduce them both to ſimple ones, then multiply theſe new Fractions as before, ſo you have the Product.

Queſt. 6. What is the Product of $\frac{3}{4}$ of $\frac{5}{6}$, by $\frac{1}{2}$ of $\frac{3}{4}$?

Anſ. $\frac{9}{96}$.

Queſt. 7. What is the Product of $\frac{3}{5}$ of $\frac{3}{4}$ by $\frac{3}{4}$ of $\frac{5}{8}$?

Anſ. $\frac{185}{940}$, or $\frac{21}{27}$.

4. If a Fraction be to be multiplied by a whole Number, put under the given whole Number an Unit for a Denominator, whereby it will be an improper Fraction, then multiply the Fractions as before. Example,

Queſt. 8. What is the Product of 24 by $\frac{2}{3}$?

Anſ. $\frac{48}{55}$ for 22, by putting an Unit under it will be $^{2}\frac{4}{8}$, and $^{2}\frac{4}{8}$ by $\frac{2}{3}$, produceth $\frac{48}{53}$ or 16.

Queſt. 9. What is the Product of 36 by $_{1}\frac{9}{2}$?

Anſ. $^{3}\frac{24}{11}$, or $29\frac{5}{11}$.

CHAP. XXIII.

Diviſion of Vulgar Fractions.

1. IF the Dividend or Diviſor are both ſimple Fractions, then multiply the Numerator of the Dividend into the Denominator of the Diviſor, and the Product is a new Numerator, and multiply the Denominator of the Dividend into the Numerator of the Diviſor, and the Product is a new Denominator, which new Fraction thus found is the Quotient you deſire. Example,

Queſt 1. What is the Quotient of $\frac{5}{8}$ divived by $\frac{3}{5}$.

Anſ. $\frac{25}{24}$, or $_{2}\frac{2}{4}$, for the firſt I multiply (5) the Numerator of the Dividend into (5) the Denominator of the Diviſor, and the Product (25) is a Numerator for the Quotient, then I multiply (8) the

$$\frac{3}{5}\Big)\,\frac{5}{\;}\,\Big(\frac{2}{24}$$

Denominator of the Dividend, into (3) the Numerator of the Diviſor, and the Product (24) I pnt into the Quotient for the Denominator, ſo I find that $\frac{20}{21}$ is the Quotient ſought.

Queſt. 3. What is the Quotient of $\frac{10}{21}$ divided by $\frac{2}{3}$.

Anſ. $\frac{30}{42}$ equal to $\frac{4}{7}$ in its loweſt Terms.

2. But if you will divide a Simple Fraction by a Compound, or a Compound by a Simple, firſt reduce ſuch a Compound to a Simple Fraction, then go on as before.

Queſt. 4. What is the Quotient of $\frac{3}{10}$ divided by $\frac{3}{4}$ of $\frac{2}{3}$?

Anſ. $\frac{29}{65}$ or $\frac{3}{60}$ firſt reduce $\frac{3}{4}$ of $\frac{2}{3}$ into a Simple Fraction, and it is $\frac{6}{12}$, by which $\frac{3}{10}$ being divided, the Quotient is $\frac{30}{60}$ equal in the leaſt Terms to $\frac{3}{5}$. And if the Dividend and Diviſor be both of Compound Fractions, reduce them both to a Simple Fraction, then divide the one by the other, as in Rule 1. foregoing.

Queſt. 4. What is the Quote of $\frac{2}{3}$ of $\frac{3}{4}$ divided by $\frac{1}{2}$ of $\frac{5}{8}$?

Anſ. $1\frac{66}{66}$, or $1\frac{3}{5}$ in its loweſt Terms.

3. If the Dividend, or Diviſor, or both, are mixed Numbers, reduce them to improper Fractions, and perform Diviſion as you are taught before.

Queſt. 5. What is the Quote of $12\frac{2}{4}$ divided by $21\frac{4}{5}$?

Anſ. $\frac{255}{406}$ for 12_3 is equal to $\frac{51}{4}$, and 21 $\frac{4}{3}$ is equal to $\frac{169}{5}$, and the Quote of $\frac{51}{4}$ divided by $\frac{109}{5}$ is as before $\frac{255}{406}$

1. If you divide a Fraction by a whole Number, or a whole Number by a Fraction, make the whole Number an improper Fraction, by putting an Unit for a Denominator to it, as taught in Rule 4. Chap. 22. and then perform Diviſion as was before taught,

Example.

Queſt. 6. What is the Quote of 8 divided by $\frac{3}{5}$?

Anſ. $\frac{40}{3}$, which is equal to $13\frac{1}{3}$, being reduced as is before directed. See the Work in the Margin.

$$\frac{3}{5}\Bigg)\frac{8}{1}\Bigg(\frac{40}{3}$$

Queſt. 7. What is the Quote of $\frac{3}{5}$ divided by 8?

Anſ. $\frac{3}{40}$ as *per* Margin.

$$\frac{8}{1}\Bigg)\frac{3}{5}\Bigg(\frac{3}{40}$$

CHAP.

CHAP. XXIV.

The Rule of Three Direct in Vulgar Fractions.

1. AS the Rule of Three in whole Numbers, ſo likewiſe in Fractions, you muſt ſee that the Fractions of the firſt and third Places be of the ſame Denominations.

2. If any of the given Fractions be compound, let them be reduced to ſimple of the ſame Value.

3. If there are given mixed Numbers, reduce them to improper Fractions by the firſt Rule of Chap. XIX.

4. If any of the three Terms is a whole Number make it an improper Fraction by conſtituting the Unit for its Denominator.

Having reduced your Fraction as is directed in the 4 laſt Rules, then proceed to a Reſolution, which is performed the ſame Way as in whole Numbers, Reſpect being had to the Rules delivered for the Working of Fractions, *viz.* Multiply the 2d and 3d Fractions together, according to the firſt Rule of Chap. XXII. and divide the Product by the firſt Fraction, according to the firſt Rule of Chap. XXIII, and the Quotient is the Anſwer.

Or, (which is better)

5. Multiply the Numerator of the firſt Fraction into the Denominator of the ſecond and third, and the Product is a new Denominator; then multiply the Denominator of the firſt Fraction into the Numerator of the 2d and 3d, and the Product is a new Numerator, which new Fraction is the 4th Proportional or Anſwer, which, if it be an improper Fraction, muſt be reduced to a whole or mixed Number by the 3d Rule of Chap. XIX. *Example.*

Queſt. 1. If $\frac{3}{4}$ Yards of Cloth coſt $\frac{5}{8}$*l.* what will $\frac{8}{10}$ Yards coſt?

Having placed the given Fractions according to the 6th Rule of Chap. X. I proceed to the Reſolution, and firſt I multiply the Numerator of the third Fraction 3 into 8 and 10, the Denominations of the ſecond and third Fractions, and the Product is 240 for a Denominator; then multiply 4 the Denominator of the firſt Fraction into 5 and 9, the Numerators of the ſecond and third Fractions, the Product is 180 for a Numerator, which Numerator 180, and Denominator 240 make $\frac{180}{240}$ *l.* for the Anſwer, equal to $\frac{3}{4}$ or 15 *s.*

$$\begin{array}{cccc} \text{Yards} & l. & \text{Yards} & l. \\ \frac{3}{4} & \frac{5}{8} & \frac{9}{10} & \frac{180}{240} \end{array}$$

$$\textit{Facit.}\quad \overset{l.}{\frac{180}{240}} \text{ equal to } \frac{3}{4}$$

Queſt. 2. If $\frac{2}{3}$ *l.* buy $\frac{5}{6}$ Yards of Cloth, what will $\frac{11}{12}$ Yds coſt at that Rate?

Anſ. $\frac{130}{180}$ equal to $\frac{11}{15}$*l.* 14*s.* 8 *d.*

Queſt. 3. If $\frac{7}{8}$ *l.* coſt $\frac{3}{4}$*s.* what will $\frac{8}{9}$*s.* buy?

Anſ. $\frac{224}{216}$ *l.* equal to 1 $\frac{1}{27}$ *l.*

Queſt. 4. If $\frac{3}{5}$ of an Ell of Holland coſt $\frac{1}{6}$*l.* what will 12$\frac{1}{\text{[illegible]}}$ Ells coſt?

Anſ. 2 *l.* 16 *s.* 1$\frac{1}{3}$*d.*

In reſolving the laſt Queſtion and the two next, obſerve the 3d Rule of the Chapter foregoing.

Queſt. 5. If $\frac{9}{10}$ of a *C.* coſt 284 *s.* what will 7 $\frac{1}{2}$ *C.* coſt at that Rate?

Anſ. 239$\frac{1}{7}$ *s.* or 19 *l.* 19 *s.* 7 *d.*

Queſt. 6. If 3$\frac{1}{4}$ Yards of Velvet coſt 3$\frac{5}{8}$ *l.* how much will 10 Yards coſt at that Rate?

Anſ. 11$\frac{7}{52}$ *l.*

Queſt. 7. If 5 Yards of broad Cloth coſt 2$\frac{3}{4}$ *l.* what will 14$\frac{3}{7}$ Yards coſt?

Anſ. 13 *l.* 9*s.* 4*d.*

In working the laſt Queſtion, and the four next, obſerve the 4th Rule of the Chapter foregoing.

Queſt. 8. If 14*lb.* of Pepper coſt 14 *s.* 6$\frac{3}{4}$ *d.* I demand the Price of 75$\frac{3}{4}$ *lb.*

Anſ. 3 *l.* 16 *s.* 8$\frac{12}{22}$*d.*

Queſt. 9. If 1 *lb.* of Cochineal coſt 1 *l.* 5 *s.* what will 36$\frac{7}{16}$ *l.* coſt.

Anſ. 47 *l.* 17 *s.* 6*d.*

Queſt 10. If a Yard of broad Cloth coſt 15$\frac{5}{8}$ *s.* what will four Pieces, each containing 27$\frac{3}{8}$ Yards coſt at that Rate.

Anſ. 85 *l.* 14*s.* 3$\frac{2}{7}$ *d.*

Queſt. 11. A Mercer bought $3\frac{1}{2}$ Pieces of Silk, each Piece contained $34\frac{2}{3}$ Ells at 6*s.* 2*d. per* Ell; I demand the Value of $2\frac{1}{2}$ Pieces at that Rate.

Anſ. 26*l.* 3*s.* $4\frac{3}{4}$*d.*

In reſolving the four next Queſtions, obſerve the 8th Rule of Chap. 19.

Queſt. 12. If $\frac{2}{5}$ of an Ounce of Silver coſt 2*s.* I demand the Price of $11\frac{2}{8}$*lb.* at that Rate.

Anſ. 35*l.*

Queſt. 13. If $1\frac{5}{7}$*lb* of Gold is worth $61\frac{5}{7}$*l.* Sterling, what is a Grain worth at that Rate?

Anſ. $1\frac{1}{2}$*d.*

Queſt. 14. If $\frac{3}{4}$ Yards of Silk is worth $\frac{3}{5}$ of $\frac{5}{4}$ what is the Price of $15\frac{2}{6}$ Ells *Flemiſh.*

Anſ. 99*l.* 6*s.* 8*d.*

Queſt. 15. If $\frac{2}{4}$ of $\frac{3}{5}$ of a Pound of Cloves coſt 6*s.* 2*d.* what coſt the C weight at that Rate?

Anſ. 69*l.* 6*s.* 8*d.*

Note, That when the Anſwer to the Queſtion in this and the next Chapter are given Fractions, they are given in the loweſt Terms.

CHAP. XXV.

The Rule of Three Inverſe in Fractions.

1. IT hath been already taught, in the 3d Rule of the 11th Chapter, how to diſcover when the 4th proportional Number, to the three given Numbers, is to be found out by a Rule of Three Direct, and when by a Rule of Three Inverſe; to which Rule the Learner is now referred.

2. When (in Fractions) you find a Queſtion to be reſolved by the Rule of three Inverſe, *viz.* when the third Term is the Diviſor, then having reduced the Terms exactly, according to the Rules in Chap. 24, multiply the Numerators of the third Fraction into the Denominators of the 2d and 1ſt Fractions, and the Product is a new Denominotor; then multiply the Denominator of the 3d Fraction in the Numerators of the 2d and 1ſt Fractions, and the Product is a new Numerator, which new Fraction thus found, is the Anſwer to the Queſtion.

Queſt. 1. If $\frac{3}{4}$ of a Yard of Cloth that is two Yards wide will make a Garment, how much of any other Drapery that is $\frac{3}{7}$ of a Yard wide will make the ſame Garment?

Anſ. $2\frac{1}{2}$ Yards.

Queſt. 2. I lent my Friend 46 *l*. for $\frac{4}{5}$ of a Year, how much ought he to lend me for $\frac{7}{12}$ Parts of a Year?

Anſ. 6*l*.

Queſt. 3. If $\frac{2}{3}$ of a Yard of Cloth that is $2\frac{1}{2}$ Yards wide will make any Garment what Breadth is that Cloth when $1\frac{3}{4}$ Yard will make the Garment?

Anſ. $\frac{57}{63}$ of a Yard wide.

Queſt. 4. How many Inches in Length of a Board that is 9 Inches broad, will make a Foot Square?

Anſ. 16 Inches in Length.

Queſt. 5. If when the Buſhel of Wheat coſt 4*s*. $\frac{3}{4}$, the Penny Loaf weighed $10\frac{2}{3}$ Ounces, what will it weigh when the Buſhel coſt 8*s*. $\frac{9}{10}$?

Anſ. $5\frac{18}{20}$ Ounces.

Queſt. 6. If 17 Men can now $24\frac{1}{2}$ Acres in $10\frac{1}{2}$ Days, in how many Days will 6 Men do the ſame?

Anſ. In 21 Days.

CHAP. XXVI.

Rule of Practice.

1. IN the ſingle Rule of Three, when the firſt of the Numbers in the Queſtion, after they are diſpoſed according to the 6th Rule of Chap. 10, happeneth to be an Unit, or 1, the Queſtion many Times may be reſolved far more ſpeedily than by the Rule of Three, which kind of Operation is commonly called Practice, and indeed is of excellent Uſe among Merchants and Tradeſmen, and others, by reaſon of its Speedineſs in finding a Reſolution to ſuch kind of Queſtions.

2. The chiefeſt Queſtions reſolvable by theſe chief Rules may be comprehended under the general Heads or Caſes following.

When the given Price of the Integer conſiſts.
1 Of Farthings under 4.
2 Of Pence under 12.
3 Of Pence and Farthings.
4 Of Shilings under 20.
5 Of Shillings, Pence, and Farthings.
6 Of Pounds.
7 Of Pounds, Shillings, Pence, and Farth.

It would be very convenient for the Practical Arithmetician to have by Heart the ſeveral Products of the 9 Digits multiplied by 12, for his ſpeedy reducing Pence into Shillings, and Shillings into Pence, which he may gain by the following Table:

12 Times	1	is	12
	2		24
	3		36
	4		48
	5		60
	6		72
	7		84
	8		96
	9		108

3. Shillings are practically reduced into Pounds, thus, *viz.* Cut off the Figure ſtanding in the Place of Units with a Daſh of the Pen, and note it for Shillings, then draw a Line under the given Number, and take half the remaining Figure (after the firſt is cut off) and ſet them under the Line, and they are ſo many Pounds; but if the laſt Figure is odd then take the leſſer half, and add 10 to the Figure ſo cut off (as before) for Shillings; as if I were to reduce 43658 Shillings into Pounds, firſt I cut off the laſt Figure (8) for Shillings, then I take half of the remaining Figures 4365 thus, half of 2 is 8, which I put under the Line, then half 3 is 1, and becauſe 3 is an odd Number, I make the next Figure 6 be 16, and I go on, ſaying, half of 16 is 8, then half of 5 is 2, which is the laſt Figure, wherefore becauſe 5 in an odd Number, I add 13 to the 8 I cut off, and it makes 18*s.* ſo that I find it to be 2182*l.* 18*s.* as *per* Margin.

4365|8.

l.	*s.*
2182	18

4. It is likewiſe convenient that the Learner be acquainted with the practical Tables following, the firſt containing the Aliquot or even Parts of a Shilling, the 2d containing the Aliquot Parts of a Pound.

The even Part of a Shilling.	is
6	$\frac{1}{2}$
4	$\frac{1}{3}$
3	$\frac{1}{4}$
2	$\frac{1}{6}$
1$\frac{1}{2}$	$\frac{1}{8}$
	1 $\frac{1}{12}$

The even Parts of a Pound. *l.*		is
10	00	$\frac{1}{2}$
6	08	$\frac{1}{3}$
5	00	$\frac{1}{4}$
4	00	$\frac{1}{5}$
3	04	$\frac{1}{6}$
2	06	$\frac{1}{8}$
2	00	$\frac{1}{10}$
1	08	$\frac{1}{12}$
1	00	$\frac{1}{20}$

Caſe 1.

5. When the Price of the Integer is a Farthing, then take the 6th Part of the given Number, which will be ſo many Three-half-pences, and if any Thing remain it is Farthings, by the 7th Rule of Chap. 9. then conſider that Threehalfpence is $\frac{1}{8}$ of a Shilling, wherefore take the 8th Part of them for Shillings, and if any Thing remain they are ſo many Three-half pences, which reduce into Pounds by the third Rule foregoing. Example what comes 67486 *lb.* to, at a Farthing *per lb.* Firſt, I take $\frac{1}{6}$ of 67486, and it is 1147 Three-half-pence, or 10$\frac{1}{2}$*d.* which with the four Farthings before, make 11$\frac{1}{2}$*d.* and 1405*s.* which by the third Rule is 70*l.* 5*s.* In all 70*l.* 5*s.* 11$\frac{1}{2}$*d.* for the Anſwer. See the Work following.

$\frac{1}{6}$	97486 at *per lb.*
$\frac{1}{8}$	11247 —— 1
$\frac{1}{10}$	140|5 —— 10$\frac{1}{2}$
	l.—*s.*—*d.*
	70 5 11$\frac{1}{2}$ *Facit.*

Other Examples follow:

1/2	8576*l* at 1 *qr.*	1/8	8347*l.* at 1 *qrs.*
1/6	1072	1/6	1043 3 *qrs.*
1/20	17|8 ——— 8*d.*	1/20	17|3 5*d.* 3 *qrs.*
	—— *s.* *d*		—— —— *s.* *d.* *qrs.*
	8 18 8 *Facit*		8 13 5 3

5. When the Price of the Integer is 2 Farthings, then take the third Part of the given Number, for ſo many Three-half-pence, and the Remainder, if any, is Half pence, then take the Eighth Part of that for Shillings, &c.

Example

1/3	7386*l.* at 2 *qrs.*	1/3	8347*l.* at 1 *qr.*
1/8	2462	1/8	2782 2 *qrs.*
	30 7 6*d.*		24|7 9*d.*
	l. *s.*		*l.* *s.* *d.*
	15 16 *Facit*		17 7 9½ *Facit*

7. When the Price of the Integer is 3 Farthings, then take half the given Number for Three-half-pence, and if any thing remain it is 3 Farthings, then take the 8th for Shillings as before, &c.

1/8	4736*l.* at 3 *qrs.*	1/2	5425*l.* at 3 *qrs.*
1/8	2368	1/8	2712 3 *qrs.*
	29|6		33|9
	l. *s.*		*l.* *s.* *d.* *qrs.*
	15 16 *Facit*		16 19 0 3 *Facit.*

Caſe 2.

8, When the given Price of the Integer, is a Part, or Parts of a Shilling, (*viz.* Pence) divide the given Number of Integers, whoſe Value is ſought, by the Denominator of the Fraction, repreſenting the even Part and the Quote is Shillings, always minding the ſeventh

Rule of the 9th Chapter, and thoſe Shillings, may be reduced into Pounds by the third Rule of this Chapter. Example: Let it be required to find the Value of 438*lb.* at 3*d. per lb.* I conſider 3*d.* is $\frac{1}{4}$ of a Shilling, and 438*lb.* will coſt ſo many 3 Pences, wherefore I divide 438 by 4 the Denominator, or $\frac{1}{4}$, and the Quote is 109 Shillings, and two remains, which is two 3*d.* or 6*d.* the whole Value is 5*l.* 9*s.* 6*d.* as by the following Work appeareth:

	438*l*. at 3*d*.				
$\frac{1}{4}$	10|9—6		*l*.	*s*.	*d*.
	5—9—6	*Facit*	5	9	6

If the Learner is minded to try the Fruitfulneſs of his Genius he may frame as many Examples as he thinks fit, and work them as before.

1. If the Price of the Integer be Pence under 12, and yet not an even Part, then it may be divided into even Parts, and ſo the Parts of the given Numbers taken accordingly, and added together, as if it were 5*d.* which is 3*d.* and 2*d.* *viz.* $\frac{1}{4}$ and $\frac{1}{6}$ of a Shilling, firſt take $\frac{1}{4}$ of the given Number, and then $\frac{1}{6}$ thereof, and add them together, and their Sums is the Anſwer in Shillings, ſtill obſerving Rule 7, of Chapter 9, for the Remainder, if any be, then bring the Shillings into Pounds by the third Rule foregoing. Likewiſe 7*d* is $\frac{1}{3}$ and $\frac{1}{4}$, ſo 2*d.* is $\frac{1}{2}$ and $\frac{1}{4}$, and 10*d.* is $\frac{1}{2}$ and $\frac{1}{3}$ and 11*d.* is $\frac{1}{4}$ and $\frac{2}{3}$ of a Shilling; or elſe many Times your Work may be ſhortened thus, *viz.* when the ſaid given Price is to be divided into even Parts of a Shilling, or of a Pound, after you have taken the firſt even Part, the other may be an even Part of that Part, as in the next Examples, where are given 439*lb.* at 5*d. per lb.* now I may divide it thus, *viz.* into 4*d.* and 1*d.* and 4*d.* being $\frac{1}{3}$ of 439*l.* and it gives 146*s.* 4*d.* and for the 1*d.* I take $\frac{1}{4}$ of 146*s.* 4*d.* which is 36*s.* 7*d.* which in all comes to 9*l.* 12*s.* 11*d.* Examples follow:

l.

	l. *d.*
	439 at 5 *per* *b.*
$\frac{1}{8}$	146 4
$\frac{1}{4}$	36 7
	18*l.* 2 11
	9*l.* 2 11 *Facit*

	Ells *d.*
	587 at 7 *per Ell*
$\frac{1}{3}$	195 8
$\frac{1}{4}$	146 9
	34*l.*
	17*l.* 2*s.* 5*d.* *Fac.*

	yds *d.*
	836 at 8 *per yd.*
$\frac{1}{3}$	278 8
$\frac{1}{4}$	278 8
	55*l.* 7 4
	27*l.* 17*s.* 4*d.* *Fac.*

	yds. *d.*
	417 at 9 *per* *yd.*
$\frac{1}{2}$	208 6
$\frac{1}{20}$	104 3
	31*l.* 2 11
	15*l.* 12*s.* 9*d.* *Facit.*

	Ells *d.*
	386 at 10
$\frac{1}{2}$	193
$\frac{1}{3}$	128 8
	32*l.* 1 8
	16*l.* 1*s.* 8*d.* *Facit.*

	l. *d.*
	534 at 11
$\frac{1}{2}$	267
$\frac{1}{3}$	178
$\frac{1}{4}$	44 6
	48*l.* 9 6
	24*l.* 9*s.* 6*d.* *Facit.*

10. When the Price of the Integer is Pence and Farthings, if it make an even Part of a Shilling, work as before; but if they are uneven, as Penny-Farthing, Penny three Farthings, *2d.* 1*qr.* or *2d.* 3*qrs.* 3*d.* 3*qrs.* or the like, then firſt work for ſome even Part, and then conſider what Part the reſt is of that even Part, and divide that Quotient thereby, then add them together,

and reduce them to Pounds as before. Example, 3470*l.* at 1*d.* 1 *qr. per lb.* Firſt I work for the Penny by dividing 3470*lb.* by 12, for 1*d.* is $\frac{1}{12}$ of a Shilling, and the Quote is 289*s.* 2*d.* then I conceive that one Farthing is the $\frac{1}{4}$ of 1*d.* and the Value of one Farthing will be $\frac{1}{4}$ of the Value of 1*d.* and therefor I take $\frac{1}{4}$ 289*s.* 2*d* which is 72*s.* 3*d.* 2*qrs.* then add them together, and they are 18*l.* 1*s.* 5*d.* 2 *qrs.* as by the Margin.

	l.		*d.*	*prs.*
	3470 at		1	1
$\frac{1}{3}$	282		2	
	72		3	
$\frac{1}{20}$	136*l.*	1*s.*	3*d.*$\frac{1}{2}$	
	l.	*s.*	*d.*	*q.*
	81	1	5	2

Caſe 4.

11. When the Price of the Integer is 2 *s.* then cut off the Figure in the Place of Units of the given Number, and double it for Shillings, and the Figures on the other Hand are Pounds. Example: 436 Yards at 3*s.* per Yarn, cut off the laſt Figure 6 and double it, make 12*s.* and the other two Figures, viz. 43, are ſo many Pounds; ſo that their Value is 43 *l.* 12 *s.* per Margin.

43	6
43 *l.*	12 *s.*

12. Hence it is evident that when the given Price of an Integer is an even Number of Shillings, then if you take half of that even Number of Shillings, and multiply the given Number of Integers thereby, doubling the firſt Figure of the Product, and ſetting it apart for Shillings, the reſt of the Product will be Pounds, which Pounds and Shillings are the Value ſought. Example: What coſt 586 yards at 8 *s.* per Yard? To reſolve which I take half of 8*s.* (the Price of a Yard) which is 4 and multiply 536 thereby, ſaying 4 times is 24, then I double the firſt Figure 4, makes 8 for Shillings. and carry 2 to the next Product, &c. find the reſt of the Product to be 214 which I note for Pounds; ſo that the Value of 536 Yards at 8 *s.* per Yard, is 214 *l.* 8 *s.* as by the Margin. Other Examples of the ſame Kind may be wrought after the ſame Manner.

536 yds	at 8
214 *l.*	1 *s.*

13. If the given Price of the Integer is an odd Number of Shillings, then work the firſt for the even Number

of Shillings by the laſt Rule, and for the odd Shillings take $\frac{1}{20}$ of the given Number of Integers, according to the 3d Rule of this Chapter, and add them together, and you have your Deſire. Examples follow:

Yds. *s*
422 at 3 *per* Yard

l *s*
42 4
21 2

63 6 *Facit*

Ells *s*
431 at 13

l *s*
258 12
21 11

208 03 *Facit*

Ells *s*
516 at 7 *per* Ell

l *s*
154 16
154 16

180 12 *Facit*

Ells *s*
324 at 17 *per* Ell

l *s*
259 04
16 05

275 09

14. Except when the given Price of the Integer is 5 *s.* for then it is ſooner anſwered by taking $\frac{1}{2}$ of the given Number, whoſe Value is ſought, as in the following Example:

$\frac{1}{2}$ | *yds* *s*
436 at 5 *per* Yd

109 *l* *Facit*

$\frac{1}{2}$ | *Ells* *s*
206 at 5 *per* Ell

51 *l* 10 *s* *Facit*

Caſe 5.

15. When the given Price of an Integer is Shillings and Pence, or Shillings, Pence, and Farthings; then divide the given Number of Integers whoſe Value you ſeek by the Denominator of the Fraction repreſenting that even Part. As for Example, what is the Price of 284 Yards at 6 *s.* 8 *d.* *per* Yard? Here I conſider that 6 *s.* 8 *d.* is one third of a Pound wherefore divide 384 by 3, and the Quote is the Anſwer, viz. 128 *l.* ſo that 384 Yards at 6 *s.* 8 *d.* *per* Yard, amounts to 128 *l.* as *per* Margin, ſtill obſerving the 7th Rule of the 6th Chapter.

$\frac{1}{3}$ | 384
128 *l*

16. When the given Value of the Integer, is Shillings

and Pence, and not an even Part of a Pound, yet many Times it may be divided into Parts, *viz.* 6*s.* 6*d.* is 4*s.* and 2*s.* 6*d.* for the 4*s.* Work according to the 12th Rule foregoing, and for the 2*s.* 6*d.* take the eighth Part of the given Number and add them together, then their Sum is the Value required.

So 8*s.* 6*d.* will be divided into 6*s.* and 2*s.* 6*d.* and the Price of the given Number may be found out as before, &*c.* Examples follow:

	Yds.	*s.*	*d.*		*Ells*	*s.*	*d.*
	386 at	8	8	*s*	240 at	5	4
$\frac{1}{2}$	128*l.*	13	4		60	0	
$\frac{1}{10}$	38	12	0		4	0	
	167*l.*	5*s.*	4*d.* *Facit*		64*l.* *Facit*		
	Ells	*s.*	*d.*		*Yds.*	*s.*	*d.*
	427 at	8	4	s	386 at	16	8
	128*l.*	2.	6	8	193*l.*	0	0
	53	7		$\frac{1}{2}$	128	13	4
	177*l.*	18*s.*	4*d.* *Facit*		321*l.*	1	4 *Facit*

17. When the given Price of an Integer is Shillings and Pence, and you cannot readily divide them according to the laſt Rule, then multiply the given Number, whoſe Value you ſeek by the Number of Shillings in the Price of the Integer, and then for the Pence work by the 8th Rule foregoing; then add the Numbers together and their Sum is their Value ſought in Shillings; as for Example: What is the Value of 392 Yards at 6*s.* 9*d. per* Yard. Here 6*s.* 9*d.* cannot be made an even Part, nor indeed can it be divided into even Parts of a Pound; wherefore I multiply the given Number of Yards 392 by 6 for the 6*s.* the Product is 2352*s.* then for the 9*d* I divide it into 6*d.* and 3*d.* and work for them by the 8th Rule foregoing; and at laſt add the Shillings together, they make 2646*s.* and by the 3d they are reduced to 132*l* 6*s.* the Value of 92 Yards at 6*s.* 9*d. per* Yard. See the Work:

392

	—392 *yds* at 6 *s.* 9 *d.*
$\frac{1}{2}$	2352
$\frac{1}{4}$	296
	98
	264|6
	132 *l.* 6 *s.* *Facit.*

In like Manner Variety of other Examples may be wrought.

18. When the given Price of the Integer is Shillings, Pence, and Farthings, then multiply the given Number of Integers, by the Number of Shillings contained in the Value of the Integer, and for the Pence and Farthings follow the 10th Rule of this Chapter.

Example.

	Ells	*s.*	*d*
	438 at	8	6$\frac{3}{4}$
s 8	1504		
$\frac{1}{2}$	219		
$\frac{1}{8}$	27		5$\frac{1}{2}$
	375		4$\frac{1}{2}$
	Fac. 187 *l.* 10 *s.* 4*d.* $\frac{1}{2}$		

	Ells	*s.*	*d.*
	135 at	9	2$\frac{1}{2}$
9	1215		0
$\frac{1}{6}$	22		6
$\frac{1}{4}$	5		7$\frac{1}{2}$
	124	3	1$\frac{1}{2}$
	Fac. 62 *l.* 3 *s.* 1 *d.* $\frac{1}{2}$		

	Ells	*s.*	*d.*
	370 at	14	2$\frac{1}{4}$
	1480		
s.	370		
14	27180		*d.*
	61		8
5	15		5
$\frac{1}{6}$	7		8
	526|4		9$\frac{1}{2}$
5	*Fa.* 263 *l.* 4 *s.* 9*d* $\frac{1}{2}$		

	Ells	*s.*	*d.*
	431 at	2	4$\frac{1}{2}$
2	862		
	107		9
	53		10$\frac{1}{2}$
	102	3	7$\frac{1}{2}$
	Fac. 51 *l.* 3 *s.* 7 *d.* $\frac{1}{2}$		

Caſe 6.

19. When the given Numbers of the Integers is Pounds, then multiply the Numbers of Integers, whoſe Value is ſought by the Price of the Integer, and the Product is the Anſwer in Pounds.

Example.

C. *l.*
42 at 2 *per* C.

84 *l. Facit*

C. *l.*
33 at 3 *per* C.

99 *l. Facit.*

C. *l.*
13 at 8 *per* C.

104 *l. Facit*

C. *l.*
48 at 12 *per* C.

576 *l. Facit.*

Caſe 7.

20. If the Price of the Integer is Pounds and Shillings, then for the Pounds work as in the laſt Rule, and for the Shillings as in the 12th and 13th Rules before-going, then add the Numbers produced from them both, and the Sum is the Value ſought.

Examples

C *l s*
56 at 2 4

92 *s*
2*l.* 9 4
4 *s*

101 4*s*

Groſs *l d*
56 at 3 7

174 *s*
3 *l* 17 8
6 *s* 2 18
1 *s*

194 *l* 6*s* *Facit*

Groſs *l s*
82 at 4 10

4 1
10 *s* 328
41

369 *l Facit.*

Groſs *l s*
36 at 3 16

78
3 *l* 19 10
15 *s* 1 6
1 *l*

98 *l* 16*s* *Facit*

21. When the given Price of an Integer conſiſts of Pounds, Shillings, Pence, and Farthings, then work for the Shillings, Pence, and Farthings firſt, according to the 18th Rule of this Chapter, and find the total Value of the given Number, as if there was no Pounds, then work with the Pounds according

ng to the 19th Rule of this Chapter, and add the Numbers hus found, and their Sum is the total Value required.

Examples of this Rule follow.

	C	l	s	d
	213 at	1	13	4
	639			
13s	213			
3d	2569		d	
1½d	53		3	
	26		7½	
1	84	8	10½	
	142 l 8s 10½			
	113			
	355 l 8s 10d½ *fac.*			

	Groſs	l	s	d
	416 at	2	9	3¾
9s	3744			
3d	104			
½d	26			
	387 | 4			
2	193 l 14s			
	832			
	1025 | 14 s *facit.*			

C	l	s	d	
37 at	3	8	10½	
296	d			8s
18	6			6d
9	3			3d
4	7½			1½d
32 | 80½d				
16 | 8s 4½d *facit.*				
111				3l
127 | 8s 4½d *facit.*				

Groſs	l	s	d	
48 at	3	15	11½	
240				
48				
700				15s
26				6d
16				4d
6				1½d
7				
38				
144				2d
182 | 6 s *facit.*				

22. When there is given the Value of an Integer, and it is required to know the Value of many ſuch Integers together, with ¾ or ½ or ⅓ of an Integer, firſt, (by the former Rules) find out the Value of the given Number of Integers, and then for ¾ of an Integer, take ¾ of the given Value of the Integer, or for ¾ take ½ of the given Value of the Integer, and for ¾

firſt take the Half of the given Value, and then half of that half, ſetting each Part under the Precedent, then adding them together, their Sum will be the required Value of the Integers and their Parts. *Example*, What is the Value of 116 Yards, at 4*s.* 6*d. per* Yard? To give an Anſwer, Firſt I work for the Value of 116 Yards by the 5th Rule foregoing, and then for the half Yards, I take half of 4*s.* 6d. which is 2*s.* 3*d.* and add to the reſt found as before, then is that Sum the total Value of 116 Yards at 4*s.* 6*d. per* Yard, which I find to amount to 26*l.* 4*s.* 3*d.* as by the Work in the Margin.

Yds.		*s.* *d.*	
116	at	4 6	
11*l.*	12*s.*		2*s.*
14*l.*	10*s.*		1*s*,
	23		*Yards*
26	4	3 *Facit.*	

And all other Examples of this Kind, are wrought the ſame Way.

Many more Queſtions may be ſtated, and ſeveral other Rules of Practice may be ſhewn according to the Methods of diverſe Authors; but what have been delivered here, are ſufficient for the Practical Arithmetician in all Caſes whatſoever.

CHAP. XXVII.

The Rule of Barter.

1. BAarter is a Rule among Merchants, which in the Exchange of one Commodity for another, inform them ſo to proportion their Rates, as that neither may ſuſtain Loſs.

2. To reſolve Queſtions in Barter, will not be difficult to him that is acquainted with the Golden Rule, or Rule of Three, it being altogether uſed in reſolving ſuch Queſtions.

Queſt. 1. Two Merchants, *viz.* A and B, barter, A hath 13 C. 3 *qrs.* 15 *lb.* of Pepper at 2*l.* 16*s. per* C. and B hath Cotton at 9*d. per lb.* I demand how much B muſt give A for his Pepper?

Anſ. 9 C. 1 *qr.*

Firſt find the Rule of Three, or the Rule of Practice foregoing, how much the Pepper is worth, ſaying, If 1 *C.* coſt 2*l.* 16*s.* what will 13 *C.* 3 *qrs.* 14*lb.* coſt?

Anſ. 38*l.* 17*s.*

Secondly, by the Rule of Three, ſay, if 9*d.* buy 1*lb.* of Cotton, how much will 38*l.* 17*s.* buy?

Anſ. $9\frac{1}{2}$ *C.* and ſo much Cotton muſt B give to A for 13 *C.* 3 *qrs* 14*lb.* of Pepper at 2*l.* 16*s.* *per* *C.* when the Cotton is worth 9*d.* *per lb.*

Queſt. 2. A and B Barter, A hath 120 Yards of Broad Cloth, worth 6*s.* *per* Yard, but in the Barter he will have 8*s.* *per* Yard; B hath Shalloon worth 4*s.* *per* Yard. Now I demand how many Yards of Shalloon B muſt give A for his Broad Cloth, making his Gain in Barter equal to that of A.

Anſ. 110 Yards of Shalloon.

Firſt (as in the laſt Queſtion) find out how B ought to ſell his Shalloon in Barter, *viz.* ſay, if 6*s.* require 8*s.* what will 4*s.* require?

Anſ. 5*s.* 4*d.*

Thus you ſee that B muſt ſell his Shalloon in Barter at 5*s.* 4*d.* if A ſells his Broad Cloth at 8*s.* *per* Yard.

It remaineth now to find out how much Shalloon B muſt give for 120 Yards of Broad Cloth, which reſolved after the Method in the firſt Queſtion of this Chapter is found to be 180, and ſo many Yards of Shalloon muſt he give A for the 100 Yards of Broad Cloth.

Queſt. 3. A and B bartered, A had 14 *C.* of Sugar worth 6*d.* *per lb.* for which he gave him 1 *C.* 3 *qrs.* of Cinnamon, I demand how B rated his Cinnamon *per lb.*

Anſ. 4*s.* *per lb.*

Queſt. 4. A and B barter, A hath 4 Tons of Brandy worth 37*l.* 16*s.* ready Money, but in Barter he hath 56*l.* 1*s.* *per* Ton, and giveth B 21 *C.* 3 *qrs.* 11*lb.* of Ginger for the 4 Tons of Brandy, I deſire to know how much B ſold his Ginger in Barter *per* *C.* and how much it is worth in ready Money.

Anſ. For 9*l.* 6*s.* 8*d.* in Barter, and it is worth 7*l.* *per* *C.* in ready Money?

Queſt. 5. A and B barter, A hath 320 Dozen of Candles, at 4*s.* 6*d* *per* Dozen, for which B giveth him 30*l.* in Money, and the reſt in Cotton at 8*d.* *per lb.* I demand how much Cotton he muſt give him more than 30*l.*

Anſ. 11 *C.* 1 *qr.*

CHAP. XXVIII.

Queſtions in Loſs and Gain.

Q. 1. A Merchant bought 436 Yards of broad Cloth for 8 *s.* 6 *d.* per Yard, and ſelleth it again at 10 *s.* 4 *d.* per Yard; now I deſire to know how much he gained in the 436 Yards?

Anſ. 31 *l.* 19 *s.* 4 *d.*

Firſt, Find out by the Rule of Three, or by Practice how much the Cloth coſt him at 8 *s.* 6 *d* per Yard, which I find to be 183 *l.* 6 *s.* then by the ſame Rule find out how much he ſold it for, *viz.* 225 *l.* 5 *s.* 4 *d.* then ſubtract 183 *l.* 6 *s.* which it coſt him, from 225 *l.* 5 *s.* 4 *d.* which he ſold it for, and there remaineth 31 *l.* 19 *s.* 4 *d.* for his Gain in the Sale thereof.

Otherwiſe, it may ſooner be reſolved thus, firſt find out how much he gained per Yard, viz. Subtract 8 *s.* 6 *d.* which he gave per Yard, from 10 *s.* 4 *d.* which he ſold it for per Yard, the Remainder is 1 *s.* 10 *d.* for his Gain per Yard, then ſay,

If one Yard gain 1 *s.* 10 *d.* what will 436 Yards gain? the Anſwer by Practice, or the Rule of Three, is 31 *l.* 19 *s.* 4 *d.* as was found before.

Queſt. 2. A Draper bought 124 Yards of Holland, for which he gave 31 *l.* I deſire to know how he muſt ſell it per Yard to gain 10 *l* 6 *s.* 8 *d.* in the whole Sale of 124 Yards?

Anſ. At 6 *s.* 8 *d.* per Yard.

Add the Price which it coſt him, viz. 31 *l.* to his intended Gain, viz. 10 *l.* 6 *s.* 8d. the Sum is 41 *l.* 6 *s.* 8 *d.* Then ſay,

If 124 Yards require 41 *l.* 6 *s.* 8 *d.* what will 1 Yard require? By the Rule of Three I find the Anſwer 6 *s.* 8 *d.*

Queſt. 3. A Grocer bought 3 *C.* 1 *qr.* 13 *lb.* of Cloves, which coſt him 2 *s.* 4 *d. per lb.* and ſold them for 52 *l.* 14 *s.* I deſire to know how much he gained in the whole?

Anſ. 8 *l.* 12 *s.*

Queſt. 4. A Draper bought 86 Kerſeys for 129 *l.* I demand how he muſt ſell them per Piece to gain 25 *l.* inlaying out 100 *l.* at that Rate? *Anſ.* 1 *l.* 14 *s.* 6 *d.* per Piece; for, As 100 is to 115*l.* ſo is 129*l.* to 148*l.*

So that by the Proportion above, I have found how much he muſt receive for the 86 Kerſeys, to gain after the Rate of 15 *per C.* Then to find how he muſt ſell them *per* Piece, I ſay,

As 86 Pieces are to 141*l.* 7*s.* ſo is one Piece to 1*l.* 14*s.* 6*d.* which is the Number ſought.

Queſt. 5. A Grocer bought 4¼ *C.* of Pepper for 15*l.* 17*s.* 4*d.* and it proving to be damnified is willing to loſe 12*l.* 10*s.* *per Cent.* I demand how he muſt ſell it *per lb.*

Anſ. 7*d.* *per lb.*

Subſtract 12*l.* 10*s.* the Loſs of 100*l.* from 100*l.* and there remains 87*l.* 10*s.* Then ſay,

As 100*l.* is to 87*l.* 10*s.* ſo is 15*l.* 17*s.* 4*d.* to 13*l.* 17*s.* 8*d.* and ſo much he muſt ſell it for, to loſe after the Rate propounded: Then to know how he muſt ſell it *per lb.* I ſay,

As 13*l* 17*s.* 8*d.* is to 4¼ *C.* ſo is 1 *lb.* to 7*d.*

Queſt. 6. A Plummer ſold 10 Fodder of Lead, the Fodder containing 19½ *C.* for 204*l.* 10*s* and gained after the Rate of 12*l.* 10*s.* *per C.* I demand how much it coſt him *per C?*

To reſolve this Queſtion, add 12*l.* 10*s.* the Gain *per Cent.* to 100*l.* and it makes 112*l.* 10*s.* Then ſay,

As 112*l.* 10*s.* is to 100*l.* ſo is 204*l.* 15*s.* to 182*l.* which 182*l.* is the Sum it coſt him in all; then reduce your 10 Fodders to Half Hundreds, and it makes 390. Then ſay,

As 300 Half Hundreds, is to 182*l.* ſo is 2 Half Hundreds to 18*s.* 8*d.* the Price of two Half Hundreds, or 1 *C. wt.* and ſo much it ſtood him in *per C. wt.*

Queſt. 7. A merchant bought eight Tuns of Wine, which being ſophiſticated, he ſelleth for 400*l.* and loſeth after the Rate of 12*l.* in receiving 100*l.* Now I demand how much it coſt him *per* Tun, and how he ſelleth it *per* Gallon to loſe after the ſaid Rate?

Anſ. It coſt him 56*l.* *per* Tun, and he muſt ſell it at 3*s.* 11*d.* $\frac{10}{21}$*qrs.* *per* Gallon, to loſe 13*l.* in receiving 100*l.*

To reſolve this Queſtion, I conſider, in the firſt Place, that in receiving 100 *l.* he loſeth 12 *l.* therefore 100 *l.* comes in for 112 *l.* laid out; wherefore to find out how much he laid out for the whole, I ſay,

As 100 *l* is to 112 *l.* ſo is 400 *l.* to 448 *l.* and ſo much the 8 Tuns coſt him: Then to find how much it coſt per Tun, I ſay,

As 8 is to 448 *l.* ſo is 1 to 56 *l.* the Price it coſt per Tun.

Now to find how he muſt ſell it per Gallon, reduce the Tuns into Gallons, which make 2016. Then ſay,

As 2016 Gallons is to 400 *l.* ſo is 1 Gallon to 3 *s.* 11 *d.* 2 *qrs* the Price he muſt ſell it at per Gallon to loſe as aforeſaid.

Queſt. 8. A Merchant bought 8 Tuns of Wine, which being ſophiſticated, he is willing to ſell for 400 *l.* and loſeth at that Rate 12 *l.* in laying out 100 *l.* upon the ſame, now I demand how much it coſt him per Tun?

Here I conſider that for 100 *l.* laid out, he received but 88 *l.* wherefore to find what 8 Tuns coſt him, I ſay,

As 88 *l.* is to 100 *l.* ſo is 400 *l.* to 454 *l.* $\frac{9}{11}$ the Price it all coſt him; then to find out how much per Tun, I ſay,

As 8 is to 454$\frac{9}{11}$, ſo is 1 to 56 *l.* 16 *s.* 4 *d.* 2 *qrs.* per Tun.

CHAP. XXIX.

Equation of Payments.

1. EQuation of Payments is that Rule among Merchants, whereby we reduce the Times for the Payment of ſeveral Sums of Money to an equated Time for Payment of the whole Debt, without Damage to Debtor or Creditor; and,

The Rule is,

2. Multiply the Sums of each particular Payment by its reſpective Time, then add the ſeveral Products together, and their Sum divide by the total Debt, and the Quotient thence ariſing is the equated Time, for the Payment of the whole Debt. *Example.*

Queſt. 1. A is indebted to B in the Sum of 100 *l.* whereof 50 *l.* is to be paid at 2 Months, and 50 *l.* at 4 Months, and the reſt at 6 Months, now they agree to make one Payment of the total Sum; the Queſtion is, What is the equated Time for Payment without Damage to Debtor or Creditor?

To reſolve this Queſtion, I multiply each Payment by its Time, *viz.*

50 *l.* Multiply'd by 2 Mon. produceth ———— 100
50 *l.* Multiply'd by 4 Mon. produceth ———— 200
30 *l.* Multiply'd by 6 Mon. produceth ———— 180

The Sum of the Product is---480

Then I divide 480 (the Sum of the Products) by 130 (the total Debt) and the Quotient is $3\frac{9}{11}$ Months for the Time of paying the whole Debt.

Queſt. 2. A Merchant hath owing him 1000 *l.* to be paid as followeth, *viz.* 600 *l.* at 4 Months, 200 *l.* at 6 Months, and the reſt (which is 200 *l.*) at 12 Months, and he agreeth with the Debtor to make one Payment of the whole, I demand the Time of Payment without Damage to Debtor or Creditor?

600 *l.* Multiplied by 4 Months is ———— 2400
200 *l.* Multiplied by 6 Months is ———— 1200
200 *l.* Multiplied by 12 Months is ———— 2400

The Sum of the Product is—6000

and the Sum of the Product (6000) being divided by the whole Debt (1000 *l.*) quotes 6 Months for the Time of Payment of the whole Debt.

3. The Truth of the Rule is thus manifeſt; if the Intereſt of that Money; which is paid by equated Time (after it is due, be equal to the Intereſt of that Money, which by the equated Time) is paid ſo much ſooner than it is due at any Rate *per C.* then the Operation is true, otherwiſe not. Example:

The Proof of the Rule of Equation of Payments.

In the laſt Queſtion 600 *l.* ſhould have been paid at 4 Months, but it is not diſcharged till 6 Months (that is 4 Months after it is all due) wherefore its Intereſt of 2 Months at 6 *per C. per Annum* is 6 *l.* and then 200 *l.*

was to be paid at 6 Months, which is the equated Time for its Payment, therefore no Intereſt is reckoned for it; but 200*l.* ſhould have been paid at 12 Months, but is paid at 6 Months, which is 6 Months ſooner than it ought, wherefore the Intereſt of 200 *l.* for 6 Months is 6*l.* (accounting 6*l. per Cent. per Annum)* which is equal to the Intereſt of 600*l.* for 2 Months, wherefore the Work is right.

Queſt. 3. A Merchant hath owing him a certain Sum to be diſcharged at 3 equal Payments, *viz.* $\frac{1}{3}$ at two Months, $\frac{1}{3}$ at four Months, and $\frac{1}{3}$ at eight Months, the Queſtion is, What is the equated Time for the Payment of the whole Debt?

In Queſtions of this Nature, *viz.* where the Debt is divided into unequal Parts, each of its Parts is to be multiplied by its Time, and the Sum of the Product is the Anſwer.

$\frac{1}{3}$ multiplied by 2 Mon. produceth $\frac{2}{3}$
$\frac{1}{3}$ multiplied by 4 Mon. produceth $1\frac{1}{3}$
$\frac{1}{3}$ multiplied by 8 Mon. produceth $2\frac{1}{3}$

The Sum of the Product is $4\frac{2}{3}$

which is $4\frac{2}{3}$ Months for the equated Time of Payment.

If inſtead of the Fractions repreſenting the Parts, you had wrought by the Numbers themſelves repreſented by thoſe Parts according to the firſt and ſecond Example, it would have been the ſame Anſwer, and ſuppoſe the Debt had been 90*l.* then $\frac{1}{3}$ of it is 30*l.* for each Payment, *viz.* at 2, 4, and 8 Months. Then,

30*l.* multiplied by 2 Mon. produceth 60
30*l.* multiplied by 4 Mon. produceth 130
30*l.* muliplied by 8 Mon. produceth 240

The Sum of the Product is 420

which divided by 90 (the whole Debt) quoted $4\frac{6}{9}$, or $4\frac{2}{3}$ Months as before.

Queſt. 4. A Merchant oweth a Sum of Money to be paid $\frac{1}{2}$ at 5 Months, and $\frac{1}{4}$ at 8 Month, and $\frac{1}{4}$ at 10 Months, and he agreeth with his Creditor to make one total Payment; I demand the Time without Damage to Debtor or Creditor? work as in the laſt Queſtion, and you will find the Anſwer to be 7 Months.

Queſt. 5. *A*. is indebted to *B* 640*l.* whereof he is to pay 40*l.* preſent Money, 350*l.* at 3 Months, and the reſt, *viz.* 250*l.* at 8 Months, and they agree to make an equated Time for the whole Payment, now I demand the Time?

In Queſtions of this Nature, (*viz.* where there is ready Money paid) you are in multiplying to neglect the Money that is to be paid preſent, and work with the reſt, as is before directed, and divide the Sum of the Products by the whole Debt, and the Quote is the Anſwer; for here 40*l.* is to be paid preſent, and hath no Time allowed; and according to the Rule it ſhould be multiplied, by its Time, which is 0; therefore 40 Times 0 is 0, which neither augmenteth nor diminiſhed the Dividend; wherefore to proceed (according to Direction) I ſay,

353 by 3 Months, produceth——1050
250 by 3 Months, produceth——2000

The Sum of the Product is 3050

which divided by 640, the whole Debt, the Quote is $4\frac{99}{64}$ Months, the Time of Payment.

ueſt. 6. A is indebted to B. in a certain Sum, half whereof is to be paid preſent Money, one third at 6 Months, and the reſt at 8 Months; now I demand the equated Time for Payment of it all?

Anſ. $3\frac{1}{2}$ onths is the Time of Payment.

Queſt. 7. A is indebted to B 120*l.* whereof $\frac{1}{2}$ is to be paid at 3 Months, $\frac{1}{4}$ at 6 Months, and the reſt at 9 Months: What is the equated Time of the Payment of the whole Sum?

Anſ at 6 Months.

Queſt. 8. A is indebted to B 420*l.* which is due at the End of 6 Months, but A is willing to pay him 140*l.* preſent, provided he can have the Remainder forborn ſo much the greed upon; I deſire to know what Time ought to be allotted for his Payment of the 280*l.* remaining?

The Operation of this Queſtion is left to the Learner, to try his Genius; and who, in this Caſe, muſt have an Eye to the Rule of Three.

CHAP. XXX.

Exchange.

1. THE Rule of Exchange informeth the Merchants how to exchange Monies, Weights, or Meaſures of the Country into (or for) the Monies, Weights, or Meaſures of another Country, and then the Rate, Reaſon, or Proportion betwixt the Money, Weights, or Meaſures of different Countries is known, it will not be difficult for the Practitioner that is well acquainted with the Rule of Proportion (or Rule of Three) to reſolve any Queſtion, wherein it is required to exchange a given Quantity of the one Kind into the ſame Value of another Kind.

2. In Queſtions of Exchange there is always a Compariſon made between the two Coins, *&c.* of two Countries, (or Kinds) or of more.

3. In Queſtions where there is a Compariſon made between two Things (whether they be Monies, Weights, *&c.* of different Kinds) there may be a Solution found by a ſingle Rule of Three, as by the following Example.

Queſt. 1. A Merchant at *London* delivered 370*l.* *Sterling* to receive the ſame at *Paris* in *French* Crowns, the Exchange $3\frac{1}{3}$ *French* Crowns *per l. Sterling,* I demand how many French Crowns he ought to receive?

In placing the Numbers, obſerve the 6th Rule of the 11th Chapter, which being done, the given Number will ſtand thus:

l. Crown *l.*
1 ——— $3\frac{1}{3}$ ——— 370

and being reduced according to the Rules of the 12th Chapter, will ſtand thus:

As $\frac{1}{2}$ is to $\frac{10}{3}$, ſo is $\frac{270}{1}$ to $1233\frac{1}{3}$:

So that I conclude he ought to receive $1233\frac{1}{3}$ *French* Crowns at *Paris* delivered for his 370*l.* at *London.*

Queſt. 2. A Merchant delivered at *Amſterdam* 587*l.* *Flemiſh* to receive the Value thereof at *Naples* in Ducats the Exchange $4\frac{1}{2}$ Ducats *per l. Flemiſh*. I demand how many Ducats he ought to receive?

The Proportion is as followeth:

l. Ducats. *l.* Ducats.

As 1 is to $\frac{24}{5}$ ſo is $\frac{587}{1}$ to $2817\frac{3}{5}$.

So I find he ought to receive $2817\frac{3}{4}$ Ducats at *Naples* for the 387*l. Flemiſh* delivered at *Amſterdam*.

Queſt. 3. A Merchant at *Florence* delivered 2478 Ducatoons, to receive the Value at *London* in Pence, and Exchange at $53\frac{1}{2}$ *Sterl. per* Ducatoon; I demand how much *Sterling* he ought to receive?

The Proportion for Reſolution is,

Duc. *d.* Duc. *d.*

As $\frac{1}{2}$ is to $\frac{100}{15}$ ſo is $\frac{347}{1}$ to 186073.

which is equal to 775*l.* 6*s.* for the Anſwer.

4. Where there is a Compariſon made between more than two different Coins, Weights, or Meaſures, there ariſeth ordinarily two different Caſes from ſuch a Compariſon.

1. When it is required to know how many Pieces of the firſt Coin, Weight, or Meaſure, are equal in Value to a known Number of Pieces of the laſt Coin, Weight, or Meaſure.

2. When it is required to find out how many Pieces of the laſt Coin, Weight or Meaſure, are equal in Value to a given Number of the firſt Sort of Coin, Weight or Meaſure

An Example of the firſt Caſe may be this, viz.

Queſt. 4 If 150 Pence at *Loudon* are equal to 3 Ducats at *Naples*, and $4\frac{5}{4}$ Ducats at *Naples* make $34\frac{1}{2}$ Shillings at *Bruſſels*; then how many Pence at *London* are equal to 139*s.* at *Bruſſels*? *Facit* 960*d*.

The Queſtion may be reſolved by two Single Rules of Three: for firſt I ſay,

If $\frac{1}{5}$ Ducats at *Naples* makes 150*d.* at *London* how many Pence will $3\frac{4}{5}$ make? *Anſ.* 240*d.*

By the foregoing Proportion we have diſcovered that $4\frac{4}{5}$ Ducats at *Naples* make 243 Pence at *London*; and by the Tenor of the Queſtion we ſee that $4\frac{4}{5}$ Ducats at *Venice* make $35\frac{1}{2}$ Shillings at *Bruſſels*, therefore 240*d.* at *London* are equal to $34\frac{1}{2}$*s.* at *Bruſſels* (for the Things that are equal to one and the ſame Thing, are alſo equal to one another) wherefore we have a Way laid open to give a Solution to this Queſtion by another Single Rule of Three whoſe Proportion is.

As $34\frac{1}{2}$ *s* at *Bruſſels* is to 240*d.* at *London*, ſo is 131 *s.* at *Bruſſels* to 960*d.* at *London*; which is the Anſwer to the Queſtion.

An Example of the ſecond Caſe may be this, viz.

Queſt. 5. If 40 *lb.* Averdupois weight at *London* is equal to 36 *lb.* Weight at *Amſterdam*, and 90 *lb.* at *Amſterdam*, makes 116 *lb.* at *Dantzick*, then how many Pounds at *Dantzick*, are equal to 122 *lb.* Averdupois weight at *London?*

Anſ. $129\frac{22}{20}$ at *Dantzick.*

This Queſtion is likewiſe anſwered by two ſingle Rules of Three, *viz.* Firſt, I ſay,

As 36 *lb.* at *Amſterdam* is to 46 *lb.* at *London*,

So is 90 *lb.* at *Amſterdam* to 103 *lb.* at *London.*

And by the Queſtion you find that 90 *lb.* at *Amſterdam*, is 116 *lb.* at *Dantzick*; and therefore 120 *lb.* at *London* is likewiſe equal thereunto; wherefore again I ſay,

As 100 *lb.* at *London* is to 116 *lb.* at *Dantzick*,

So is 112 *lb.* at *London* to $129\frac{22}{20}$ *lb.* at *Dantzick.*

By which I find that $129\frac{22}{20}$ *lb.* at *Dantzick* are equal to 112 Averdupois weight at *London.*

5. There is a more ſpeedy Way to reſolve ſuch Queſtions as are contained under the two Caſes before mention'd laid down by Mr. *Kerſey* in the third Chapter of his Appendix to *Wingate*'s Arithmetick, where he hath given two Rules for the Reſolution of the Queſtions pertinent to the two ſaid Caſes.

6. But I ſhall lay down a general Rule for the Solution of both Caſes; and 1ſt, Let the Learner obſerve the following Directions in the placing of the given Terms, *viz.*

7. Let theſe be made two Columns, and in the Columns ſo place the given Terms one over the other, as that in the ſame Kind one with the other.

Having thus placed the Terms, the general Rule is, to obſerve which of the ſaid Columns hath the moſt Terms placed in it, and multiply all the Terms therein continually, and place the laſt Product for a Dividend, then multiply the

Terms in the other Column continually, and let the laſt Product be a Diviſor, and the Quotient thence ariſing will be the Anſwer to the Queſtion.

So the Example of the firſt of the ſaid Caſes being again repeated, *viz.* If 150 Pence at *London* make 3 Ducats at *Naples*, and 34 Shillings at *Bruſſels*, then how many Pence at *London* are equal to 13 Shillings at *Bruſſels?*

The Terms being placed according to the 7th Rule, will ſtand as followeth;

	A	B	
Pence at *Lond.*	150	3	Ducats at *Naples.*
Ducats at *Nap.*	$4\frac{1}{2}$	$34\frac{1}{5}$	Shillings at *Bruſſels.*
Shil. at *Bruſſ.*	138		

Having thus placed the Terms, that in either Column there are two Terms of one Kind, then obſerve that the Column under A hath moſt Terms in it, therefore they muſt be multiplied together for a Dividend, *viz.* 150 multiplied by 4, produceth $\frac{600}{5}$, which multiplied by 138, produceth $\frac{496809}{5}$, for a Dividend, then in the Column under B there are 3, and $43\frac{1}{2}$ which multiplied together produce $\frac{207}{2}$, the Quotient is 960 Pence of the Anſwer as before.

Again, Let the Example of the ſecond Caſe be again repeated, *viz.* If 40 *lb.* Averdupois weight at *London* make 36 *lb.* Weight at *Amſterdam*, and 90 *lb* at *Amſterdam* make 116 *lb.* at *Dantzick*, then how many Pounds at *Dantzick* are equal to 112 *lb.* Averdupois weight at *London.*

The Terms being diſpoſed according to the 7th Rule foregoing, will ſtand thus:

	A	B	
lb. at *London*	40	36	*lb.* at *Amſterdam*
lb. at *Amſterdam*	90	116	*lb.* at *Dantzick*
		112	*lb.* at *London*

whereby I find the Terms under B, multiplied together, produce 497712 for a Dividend, and the Terms under A, *viz.* 40 and 90, produce 3600 for a Diviſor, and a Diviſion being finiſhed, the Quotient giveth $129\frac{3432}{3000}$ Pounds, *Dantzick* or the Anſwer.

CHAP. XXXI.

Single Poſition.

1. NEgative Arithmetick, called the Rule of Falſe, is that by which we find out a Truth, by Numbers invented or ſuppoſed, either ſingle or Double.

2. The Rule of Single Poſition is, when at once, *viz.* by one falſe Poſition, or feigned Number, we find out the true Number ſought.

3. In the ſingle Rule of Falſe, when you have made Choice of your Poſition, work it according to the Tenor of the Queſtion, as if it were the true Number ſought; and if by the ordering your Poſition you find either the Reſult too much or too little, you may then find out the Number ſought by this Proportion following, viz.

As the Reſult of your Poſition is to the Poſition, ſo is the given Number to the Number ſought.

Example.

Queſt. 1. A Perſon having about him a certain Number of Crowns, ſaid, if a 4th, 3d, and 6th of them were added together, they would make juſt 45 Crowns, now I demand the Number of Crowns he had about him?

Anſ. 60 Crowns.

To reſolve this Queſtion, I ſuppoſe he had 24 Crowns (or any other Number that will admit of the like Diviſion) now the 4th of 24 is 6, and the 3d is 8, and the 6th is 4, all which Parts, (6, 8, and 4) being added together, make but 18, but it ſhould be 45, wherefore I ſay by the Rule of Three,

As 18, the Sum of the Parts, is to the Poſition 24, ſo is 45 the given Number, to 60, the True Number ſought.

For the 4th of 60 is 15, and the 3d of 60 is 20, and the 6th of 60 is 10, which added together make 45.

CHAP. XXXII.

Double Poſition.

1. THE Rule of Double Poſition is when two falſe Poſitions are aſſumed to give a Reſolution to the Queſtion propounded.

2. When any Queſtion is ſtated in Double Poſition, make ſuch a Croſs as in the Margin.

a *b*
X
d *c*

3. Then make Choice of any Number you think may be convenient for your working, which call your firſt Poſition, and place it at the End of the Croſs at *a*, then work with this Poſition, as if it were the true Number ſought, according to the Nature of your Queſtion; then having found out your Error, either too much or too little, place it at the Side at *d*, then make choice of another Number of the ſame Denomination with the firſt Poſition (which call your ſecond Poſition, and place it on the Side of the Croſs at *b*; then work with this Poſition as with the former, and having found out your Error, either too much or too little, place it on that Side of the Croſs, at *c*; and then the Poſition will ſtand at the Top of the Croſs, and the Errors at the Bottom, each under his Correſpondent Poſition, and then multiply the Errors into the Poſition croſs wiſe, that is, multiply the firſt Poſition by the ſecond Error, and the ſecond Poſition by the firſt Error, and put each Product over its Poſition.

4 Having proceeded ſo far, then conſider whether the Errors are both alike; and if they are alike; then ſubſtract the leſſer Product from the greater, and ſet the Remainder for a Dividend; then ſubſtract the leſſer Error from the greater, and let the Remainder be a Diviſor, and the Quotient ariſing by this Diviſion is the Anſwer to the Queſtion.

5. But if the Errors are unlike, that is, one too much and the other too litle, then add the Products of the Poſitions and Errors together, and their Sums ſhall be a Dividend, then add the Errors together, and their Sum ſhall

be a Diviſor, and the Quotient ariſing hence is the Anſwer.

Queſt. 1. A, B, and C built a Houſe, which coſt 76 *l.* of which A paid a certain Sum unknown, B paid as much as A, and 10*l.* over, and C as much as A and B: Now I deſire to know each Man's Share in that Charge?

Having made a Croſs according to the ſecond Rule, I come according to the third Rule to make Choice of my firſt Poſition, and here I ſuppoſe, A paid 6 *l.* which I put upon the Croſs as you ſee, then B paid 16 *l.* (for it's ſaid he paid 10*l.* more than A) and C paid 22 *l.* (for it's ſaid he paid as much as A and B) then I add their Parts.

l.			*l.*
9		A	6
19		B	16
28	120 168 288	C	22
—	6 X 9		——
6	2) X (14	Sum	44
	32 X 20		
76	12		76
56			44
—			——
132		Error	32

And they amount to 44, but it is ſaid they paid 76*l.* wherefore there is 32 too little, which I note down at the Bottom of the Croſs under its Poſition for the firſt Error.

2*dly*, I ſuppoſe A paid 6 *l.* then B paid 19*l.* and C 28 *l.* all which added together make 56, but they ſhould make 76, wherefore the Error of this Poſition is 20, which I put at the Bottom of the Croſs under its Poſition for the 2d Error; then I multiply the Errors and Poſition Croſs-wiſe, *viz.* 32 (the Error of the firſt Poſition) by 9 (the 2d Poſition) and the Product is 288. Then I multip'y 20 (the Error of the 2d Poſition) by 6 (the firſt Poſition) and the Product is 120.

Then (according to the 4th Rule) I ſubſtract the leſſer Product from the greater, *viz.* 120 from 288, becauſe the Errors are both alike, *viz.* too little, and there remain-

eth

maineth 168 for a Dividend ; then ſubſtract 22 (the leſſer Error) from 32, the greater Error, and the Remainder is 12, for a Diviſor ; then I divide 168 by 12, and the Quotient is 14 for the Anſwer, which is the Share of A in the Payment.

6. Again, 2dly, If the Errors had been both too big, it had had the ſame Effect, as appeareth by the following Work ; for firſt, I ſuppoſe A paid 20*l.* then B paid 30*l.* and C 50*l.* which in all is 100*l.* but it ſhould have been no more than 76, wherefore the firſt Error is 24 too much. Again, I ſuppoſe A paid 18*l.* then B muſt pay 28*l.* and C muſt pay 46*l.* which in all is 92*l.* but it ſhould have been but 76.

20 A		A 18
30 B		B 28
50 C	320 112 452	C 28
	20 X 18	
100 Sum	(8 (14	Sum 92
76	Subſtr. 24 16	Subſtr. 76
	8	
24 Error		Error 16

where the ſecond Error is 16 too much ; then I multiply 20 (the firſt Poſition) by 16 (the 2d Error) and the Product is 320 ; again, I multiply 18 (the 2d Poſition) by 24 (the firſt Error) and the Product is 432. Then becauſe the Errors are both too much, I ſubſtract 320 (the leſſer Product) from 432 (the greater Product) and there remaineth 112 for a Dividend ; likewiſe I ſnbſtruct 320 (the leſſer Error from 24 (the greater Error) and the Difference is 8 for a Diviſor ; then perform Diviſion, and the Quotient is 14, as before for the Anſwer.

Again, 3dly, If the Errors had been the one too big, and the other too little, Reſpect being had to the 5th Rule foregoing, the Anſwer would have been the ſame ; as thus, I take for my firſt Poſition 6, and then the Error is 32 too little ; then I take for my ſecond Poſition 18, and then the Error is 16 to much ; then I multiply the Poſitions and Errors croſs-wiſe, and the Products are 96 and 576, and becauſe the Errors are unlike, *viz.* one too big, and another to little, I add the Product 25 and 576 together

96	672	576
6	X	16
48)		(84
32		16
	48	

ther, and their Sum is 672 for a Dividend; I likewiſe add the Errors 32 and 16 together, and their Sum is 48 for a Diviſor, thus having finiſhed the Diviſion, I find the Quotient to be 14, which is the Anſwer, as was found out at the two ſeveral Trials before.

For the Proof of the Work I ſay,
If A paid——————————14
Then B paid 14 and 10 (that is)——24
Then C paid 14 and 24 (that is)——38

The Sum of all is———76

which is the total Value of the Building, and equal to the given Number.

Thoſe who deſire to ſee the Demonſtration of this Rule, let them read the 7th Chapter of Mr. *Kerſey*'s Appendix to Mr. *Wingate*'s Arithmetick, *Petiſcus* in his 5th Book of his *Trigonometria*, or Mr. *Oughtred* in his *Clavis Mathematica*.

Queſt. 2. Three Perſons, A, B, and C, diſcourſed together concerning their Age; quoth A, I am 18 Years of Age; quoth B, I am as old as A, and half C; and quoth C, I am as old as you both, if your Years were added together. Now I deſire to know the Age of each Perſon?

Anſ. A is 18, B is 54, and C is 72 Years of Age.

Queſt. 5. A Father lying at the Point of Death, left to his Three Sons, *viz.* A, B, and C, all his Eſtate in Money, and divided it as followeth, *viz.* to A, he gave Half wanting 44 *l.* to B, he gave a Quarter and 24 *l.* over, and to C he gave the Remainder, which was 38 *l.* leſs than the Share of B; now I demand what was the Sum left, and each Man's Part?

Anſ. The Sum bequeathed was 588 *l.* wherefore A had 250 *l.* B had 210 *l.* and C had 128 *l.*

Queſt. 4. Two Perſons, *viz.* A and B had each in their Hands a certain Number of Crowns, and A ſaid to B, If you give me one of your Crowns, I ſhall have five Times as many as you; and ſaid B to him again, If you give me one of yours, then we ſhall each of us make an equal Number; now I demand how many Crowns had each Perſon?

Anſ. A had 4 and B had 2 Crowns.

Queſt. 5. What Number is that unto which if I add 1—4th of itſelf, and from the Sum ſubſtract 1—8th of itſelf, the Remainder will be 216?

Anſ. 192.

Many more Queſtions may be added, but theſe well underſtood will be ſufficient, (even for the meaneſt Capacity for the Reſolution of any other Queſtion pertinent to this Rule.

There may be an Objection made, becauſe we have not treated particularly upon Intereſt and Rebate; but the Operation of ſuch Queſtions being more applicable to Decimals, are omitted, till we come to acquaint the Learner therewith.

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